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Simon and Michael Skinner
Amax Petroleum of Canada Inc.

Applications for Review or Development of Facilities, Wells, Spacing Order, and Holdings

Hayter Field - Provost Area


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ERCB

Simon and Michael Skinner
Amax Petroleum of Canada Inc.

Applications for Review or Development of Facilities, Wells, Spacing Order, and Holdings

Hayter Field - Provost Area

HAYTER FIELD
APPLICATION FOR REVIEW OF WELLS, OIL PRODUCTION FACILITIES AND SPACING ORDER BY SIMON AND MICHAEL SKINNER
APPLICATIONS FOR HOLDINGS, SPACING ORDER, WELLS AND OIL PRODUCTION FACILITIES BY AMAX PETROLEUM OF CANADA INC.

ERCB D 93-3

March 1993

Published by

Energy Resources Conservation Board
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Calgary, Alberta
T2P 3G4

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ENERGY RESOURCES CONSERVATION BOARD

Calgary, Alberta

APPLICATION NO. 910526
SIMON AND MICHAEL SKINNER
APPLICATION FOR REVIEW OF WELLS, FACILITIES AND SPACING ORDER

APPLICATIONS NO. 910289, 910790, 910972 AND 910890 TO 910905 INCLUSIVE
AMAX PETROLEUM OF CANADA INC.
APPLICATIONS FOR HOLDINGS, SPACING ORDER, WELLS AND FACILITIES
HAYTER FIELD

Decision D 93-3

1 INTRODUCTION

1.1 Applications and Interventions

Application No. 910526 was made on 4 April 1991 by Simon and Michael Skinner (the Skinners) pursuant to section 42 of the Energy Resources Conservation Act (the Act) for a review of the following Energy Resources Conservation Board (ERCB) approvals:

(a) Battery Approval No. FS04587, an oil battery located at Legal Subdivision 10 of Section 16, Township 41, Range 1, West of the 4th Meridian (the 10-16 battery);

(b) Well Licence Nos. 0036069, 0077707, 0126936, 0126937, 0126950, 0126951, 0128313, 0128314, 0128315, 0129290, 0129291, 0129293, 0130375, 0130376, 0130379, 0130430, 0130921, 0131797, 0131799, 0131802, 0131803, 0140545, 0143409, 0143799, 0144248, 0144249, 0144250, 0144251 and 0144255, that produce or are capable of producing to the 10-16 battery;

(c) All satellite production facilities that produce or are capable of producing well effluent to the 10-16 battery; and

(d) Board Order No. IW 9011.

Amax Petroleum of Canada Inc. (Amax) applied for approval of the following:

(a) Application No. 910289, pursuant to section 5.190 of the Oil and Gas Conservation Regulations (the Regulations), to establish two holdings, one comprising Section 16 and one for the South-east quarter of Section 21, Township 41, Range 1, West of the 4th Meridian for the production of oil from the Dina Member of the Mannville Group and pursuant to section 71, subclause (4) of the Oil and Gas Conservation Act, to suspend the application of Part 4 of the Regulations and provide a special spacing order for wells drilled or to be drilled within the holdings. In the rest of this report this application is referred to as the "holding/spacing application."

(b) Application No. 910790, pursuant to section 7.001 of the Regulations, for approval to construct a satellite production facility at Quadrant D, Legal Subdivision 10 of Section 16, Township 41, Range 1, West of the 4th Meridian (the 10D-16 satellite).

(c) Application No. 910972, pursuant to Part 4 of the Pipeline Act, to construct approximately 2 kilometres (km) of 88.9 millimetre (mm) outside diameter test and production pipelines to transport oil well effluent from sixteen wells proposed to be drilled in Section 16, Township 41, Range 1, West of the 4th Meridian.

(d) Applications No. 910890 to 910905 inclusive, pursuant to section 2.020 of the Regulations, for sixteen well licences for wells to be drilled from surface locations at Legal Subdivisions 7, 10, 14, 15 and 16 of Section 16, Township 41, Range 1, West of the 4th Meridian, for the production of oil from the Dina Member of the Mannville.

An intervention opposing the Amax applications was filed by the Skinners based on the impacts the applications would have on the Skinners' dairy operation, the environment and the health of their livestock and families.

Interventions were also filed by the Alberta Cattle Commission, the Christian Farmers Federation of Alberta, and the Shell Caroline Agricultural Society.

The Alberta Environmental Centre filed a submission as an interested party in the proceeding.

1.2 The Hearing

The Board decided to consider the Amax and Skinner applications at one hearing. A public hearing of the applications was held in Provost, Alberta, and was conducted on 13 to 17 and 27 to 31 January 1992, 24 to 28 February 1992, 13 to 14 and 21 to 24 April 1992, and 4 to 6 May 1992. The hearing was held before Board Members F. J. Mink, P.Eng., B. F. Bietz, Ph.D., P.Biol., and N. G. Berndtsson, P.Eng. (the Board). A site visit to the Skinner dairy and Amax operations on Section 16 was conducted 13 January 1992, and was attended by Amax, the Skinners, the Board, Board staff and other participants at the hearing. Those who appeared at the hearing are listed on the following table.

THOSE WHO APPEARED AT THE HEARING

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Amax Petroleum of Canada Inc. (Amax) P. B. Budd C. D. Johnstone	C. A. Hemstock, P.Eng. B. G. Berkan, P.Eng. W. G. Schultz G. A. Atkins, DVM J. A. Lore, P.Ag. of Jim Lore and Associates Ltd.

THOSE WHO APPEARED AT THE HEARING (cont'd)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Amax Petroleum of Canada Inc. (Amax) (cont'd)	G. A. Nordstrom, DVM J. K. Farries, P.Eng. of Farries Engineering (1977) Ltd. D. M. Leahey, Ph.D of Western Research A. R. Scheibner, P.Ag. of Western Oilfield Environmental Services Ltd. D. Headdon, M.Sc. of Western Oilfield Environmental Services Ltd. R. Clissold, P.Geol. of Hydrogeological Consultants Ltd.
Skinner Bros. Dairy Farms Ltd. (Skinners) D. B. Roth J. P. Kudrinko	M. Skinner S. Skinner J. Skinner C. Skinner W. Wong, C.E.T. of Entech Environmental Services Ltd. D. Mancuso, P.Eng. of Enex Engineering Ltd. J. A. McCarthy of S.E.M. Consultants Ltd. A. J. Webb of S.E.M. Consultants Ltd. K. U. Weyer, Ph.D. of W.D.A. Consultants Ltd. M. Genest, Ph.D. of Clinical and Consulting Psychological Services B. Beck, DVM of Alberta Agriculture J. Ferguson, DVM of Western College of Veterinary Medicine

THOSE WHO APPEARED AT THE HEARING (cont'd)

Principals and Representatives (Abbreviations Used in Report)	Witnesses
Skinner Bros. Dairy Farms Ltd. (Skinners) (cont'd)	J. Wasmuth of Galigan MacAllister Associates Inc. S. H. Poulsen, DVM of Wainwright Veterinary Clinic (1990) Ltd. M. Zelensky, P.Eng., of Concord Environmental R. Corbett, M.Sc. of Alberta Agriculture
Alberta Environmental Centre	R. W. Coppock, DVM M. S. Mostrom, DVM D. H. McNabb R. Coleman, Ph.D.
Alberta Cattle Commission	T. Livingston D. Overguard
Christian Farmers Federation of Alberta	H. Bulten
Shell Caroline Agricultural Society	D. Jones
N. Taylor	N. Taylor
W. E. Bocock	W. E. Bocock
Energy Resources Conservation Board Staff C. S. Richardson, C.E.T. R. D. Heggie, Counsel L. A. Schmidt, C.E.T. B. B. Boyd I. T. Weleschuk, P.Ag. J. J. Kennelly, Ph.D., P.Ag. H. B. Schiefer, DVM, Ph.D.	

1.3 Background

1.3.1 Area Description

The area of application is in the Hayter Field which is defined by Board Order F 6123 (Figure 1). The Field comprises 79 sections of land in Townships 40 and 41, Range 1, W4M. Oil production is primarily from the Dina Member of the Mannville Group (Dina) and contains small amounts of hydrogen sulphide (H_2S). There is also some oil production from the Sparky Member of the Mannville Group (Sparky).

The Dina typically occurs as a stream deposited sandstone that overlies the erosional surface of older Devonian age carbonate rock. The sandstone has high permeability and porosity and the reservoir pressure within the sandstone is supported by a strong water drive. Water will migrate to a wellbore from below the oil zone and create an effect referred to as water coning. Well drainage areas are limited due to the water coning problem and as a consequence, close spacing between wells is required to recover the reserves. As a result of these fluid and reservoir characteristics, some Dina pools in the Hayter Field have special drilling spacing units (DSU's) which result in a high well density. Similar well densities are prevalent in the Dina pools in the larger Provost Field which lies to the south of the Hayter Field.

The Dina A Pool in the Hayter Field was discovered in 1954, although full development of the pool did not commence until the mid 1980s. In 1987, the pool was placed on Good Production Practice (GPP) which allowed for increased production rates subject to good reservoir management. The pool area consists of approximately 1400 hectares (ha) and the portion of the pool subject to the holding/spacing application proposed by Amax is Section 16 and the South-east quarter of Section 21-41-1 W4M (the SE of 21). The first well drilled in the area of application was located at Lsd 10-16-41-1 W4M. Pool development in the area initially proceeded on 64 ha DSU's until 1987 when 4 ha DSU's with central target areas were approved for Section 16. In 1988, 4 ha DSU's were approved for the drilling of Dina oil wells in the SE of 21 and in 1990, an infill well order (Order No. IW 9011) was approved for Lsd 10 of Section 16. This order was in response to a spacing application by Ladd Exploration Company (Ladd) to provide for the drilling of 2 wells, one of which would be a horizontal well. The order provided for a minimum subsurface interwell spacing of 75 metres (m) between wells producing from the same pool in Lsd 10 of Section 16.

Construction of the 10-16 battery was completed in 1987. Twenty-nine Dina oil wells produce to the 10-16 battery, 26 of which are located in Section 16. Satellite facilities produce well fluids via pipelines to the 10-16 battery from locations at 4-16-41-1 W4M, 10-16-41-1 W4M, and 16-16-41-1 W4M.

Sparky oil development since the late 1960s through to the late 1970s has also resulted in a considerable number of wells, pipelines and an oil battery in Section 16. A Sparky oil production battery located at Lsd 8-16-41-1 W4M (the Sparky battery) was built in 1968, and modified over the years to accept production from new wells. Until 1987 the Sparky battery also accepted production from Dina wells. The Sparky battery currently receives production from 26 wells, 11 of which are located in Section 16.

Concurrent with oil and gas development on Section 16 has been the development of the Skinner dairy farm. The Skinner family dairy has operated since 1967, when Mr. John Skinner, father of Messrs. Simon and Michael Skinner, expanded the farm operations to start commercial milk production. In

1976, Simon and Michael took over operation of the farm from John Skinner and have since expanded the operation. In 1981, a 120-head capacity milking barn was constructed and the Skinners commenced a more intensive breeding program to improve the genetic pool within the herd. The genetic improvements have continued to the present and the herd currently consists of about 260 head of cows, heifers and calves. In 1986, the Skinners undertook several construction projects on the farm that included the building of a new calf barn, new corrals, the construction of a new house, additions to another house and the drilling of a new water well. In 1987 another water well was drilled, bringing the total number of farm water wells to seven. In addition to the dairy, the Skinners cultivate approximately 1200 ha of land for grain production.

The Skinner farmstead is located in the north-half of Section 16, in what has been described as a topographic bowl (the Skinner bowl) set within regionally elevated low rolling hills (Figure 2). The ground elevations in the vicinity of the farm range from approximately 740 to 770 m above sea level, and the mean elevation of the Section is from 50 to 100 m higher than the regional topography. The Skinner bowl is enclosed on the north, west and south by higher land and is open to the east with a narrower coulee running out to the north-west. A permanent slough is located on the east side of the farm and is used for watering livestock in the summer. The low rolling topography and the local climate create a parkland environment of poplar trees and grassy knolls. Much of Section 16 has been cultivated for crop production. Surrounding much of the Skinner bowl are oil wells, pipeline right-of-ways and production facilities. The 10-16 battery is located on a low hill approximately 200 m south and 20 m above the farmyard.

The Skinner farm is home to 18 individuals, comprised of four families living in four residences. John and Pat Skinner and the family of Blaine Skinner both reside on the North-west corner of Section 16. These two residences, located on higher ground and approximately 800 m north-west of the 10-16 battery, are farthest from the dairy operation and Section 16 oilfield activity. The family of Michael Skinner reside on the west side of the Skinner bowl in Lsd 13-16 approximately 700 m north-west of the 10-16 battery. The family of Simon Skinner reside lower in the Skinner bowl in Lsd 15 approximately 350 m north of the 10-16 battery. The 10-16 battery is within 250 m of the milking barn. The milking barn is the main area of daily work activity for the Skinner family.

The Skinners rely on groundwater to supply the four families resident on the farm, as well as for their dairy operation. Of the seven water wells in or near the Skinner farmsite, four are currently in use and tied into the water system used to supply water for the dairy. The three unused wells have "sanded in" and can no longer be pumped. All seven wells appear to be completed in the Grizzly Bear shale at a depth of between 110 to 130 m from surface. The wells appear to be completed into unconsolidated surficial material, although they may be in or near the bedrock; driller's logs for the wells are inconclusive. The low sodium levels and other water quality parameters indicate that the primary source of water in the wells is surficial aquifers.

1.3.2 Sequence Of Events Leading To The Hearing

Over the years that the Sparky and Dina oil pools have been developed, the Skinners and Ladd (predecessor to Amax) established a working relationship that allowed concurrent development of both industries. Prior to 1987 the production tended to be largely from Sparky oil operations with limited environmental and social impact.

The Skinners based their request for a review on the impacts they believed had resulted from the Ladd operations involving the production of sour crude oil from the Dina. Those impacts were described as ongoing odours and possible health impacts due to emissions from the batteries, wells and facilities; the effects of H_2S and sulphur dioxide (SO_2) emissions from the 10-16 battery on the Skinner dairy herd; contamination of land and water from oil sprays and oil and salt-water spills; health and safety hazards from a field fire caused by operational upsets at the 10-16 battery; and from noise, dust, increased traffic and other sources of stress. In the request for a review the Skinners stated that they had little knowledge of the rights of a landowner during their prior working relationship with Ladd and were unaware of potential impacts from oilfield activities in proximity to a farm.

Prior to the current applications, Ladd applied in September 1990 for an amendment of Approval No. 32027 for the construction of two pipelines from a four well pad located in Lsd 10 of Section 16 to a field satellite facility located in the same Lsd. The Skinners, at that time, requested the Board review the licences for the four wells located in Lsd 10 of Section 16, in accordance with section 42 of the Act. A public hearing was scheduled to consider the pipeline applications and a review of the four well licences. Prior to the hearing Ladd and the Skinners entered into an agreement regarding the proposed pipelines and four wells which resulted in withdrawal of the request for review. This allowed Ladd to produce the four wells to the 10-16 battery and the hearing was cancelled.

Also prior to the submission of the current applications before the Board, Ladd applied and subsequently withdrew three well licence applications and an initial holding/spacing application. This holding/spacing application was for the production of oil from the Dina for Section 16 and would have allowed for a subsurface interwell distance of 75 m and a buffer zone of 50 m to the sides of Section 16. Ladd identified 57 potential infill well locations within Section 16. The Skinners withdrew their earlier support for the initial holding/spacing application based on their belief that they were misinformed about the extent of Ladd's development plans. Ladd decided that it would withdraw the applications and prepare a comprehensive development plan that would more effectively address the Skinners' concerns and provide a directional plan for its operations on Section 16. The holding/spacing application and well licence applications currently before the Board represent Amax's comprehensive plan for the development of the Dina A Pool in Section 16.

The Board considers the applications before it to represent a very unusual situation. The type and scale of development of the two industries, that is intense oil and agricultural development, coupled with their proximity, is uncommon and relatively unique in the Board's experience. The Board retained a veterinary toxicologist and dairy production consultant to assist Board staff in the review of the submissions and in cross examination at the hearing.

1.3.3 Current Status Of Amax Operations

Within Section 16 there has been no new oil and gas development since early 1991 but Amax has monitored and improved its existing wells and facilities as required. Amax conducted an air monitoring program in 1991 to identify sources of H_2S and SO_2. The program revealed the 10-16 battery (Dina production) and certain well heads as sources of H_2S and changes were made to the battery and wells to correct the emission problems. A continuous air monitoring unit has been on location between the 10-16 battery and the Skinner dairy barn since 1990. This has allowed Amax to identify the times and directions from which H_2S emissions may occur and resulted in modifications to the 10-16 battery to reduce fugitive odours and emissions. These modifications are discussed in more detail in

Section 2.2.1. With respect to the existing wells on Section 16, all producing wells are powered by electric screw pumps and the surplus portions of the surface leases are returned to agricultural use. Some of the locations are fenced to prevent unauthorized access or access by cattle. There is no trucking of fluids from the wells as all wells are produced by pipeline to either the 10-16 or the Sparky battery.

2 SECTION 42 REVIEW OF AMAX OPERATIONS

2.1 Introduction

The Skinners requested that the Board review the existing Amax operations and spacing order pursuant to section 42 of the Act. Section 42 states that "The Board may review, rescind, change, alter or vary an order or direction made by it, or may rehear an application before deciding it." The Board is of the view that section 42 requires the consideration of two questions. The first is whether the Board should review the existing licences and approvals. The Skinners questioned the reliability and safety of the Amax facilities and its operations. They submitted that the intensity of the development, coupled with its proximity to the Skinners' dairy and residences, greatly increased the risk of adverse impact upon the farm, particularly if the facility was poorly designed or operated. The Board determined that it should review the existing licences and approvals and called for that review in the Notice of Hearing. The second question, to be determined by the Board in this report, is whether the existing Amax licences and approvals should be rescinded, changed, altered or varied.

2.2 Issues

The Board believes the issues to be addressed in the section 42 review are:

- general Amax well and battery operations,
- dairy farm operating practices,
- environmental impacts, including:
 - atmospheric impacts
 - subsurface impacts
 - surface impacts
- effects on the dairy herd,
- social impacts, and
- company/landowner communications.

2.2.1 Well And 10-16 Battery Operations

2.2.1.1 Views Of The Skinners

The Skinners submitted that several factors related to the Amax operations create undue risk to the livelihood of the Skinner families, their personal health, and the health of their livestock. Because of the concentration and proximity of oilfield development, particularly the 10-16 battery, to their dairy operation, the Skinners argued that the impacts and risks in this case are far greater than that normally associated with similar oilfield operations. They described past experiences with fires from the 10-16 and Sparky batteries; crop damage from oil sprays; frequent odours, particularly during winter months; concerns about the potential for surface water pollutants from the Amax facilities; numerous salt-water

spills caused by underground tank and pipeline ruptures; and the stress on the Skinners and their dairy herd caused by the Amax operations.

The Skinners stated they were concerned about the effects that drilling and completion operations were having on their freshwater aquifers. The Skinners perceived contamination of aquifers during drilling operations as a real threat. They noted, contrary to Amax's assertion of using fresh water as a drilling fluid, that Amax had on several occasions used a diesel invert drilling system to solve well control problems at a depth equivalent to their domestic water wells. The Skinners said the amount of surface casing previously run by Amax was insufficient to adequately protect the aquifers from which they were obtaining their water. Their deepest water well was approximately 130 m and they noted Amax was setting only 90 to 95 m of surface casing. The Skinners submitted that surface casing should be set at least to the Grizzly Bear Shale or preferably 25 m below the Ribstone Creek Sandstone, at a depth of approximately 260 m. Witnesses for the Skinners disagreed with Amax that cementing the production string full length provided adequate protection of the aquifers below the surface casing down to the Ribstone Creek. Further, they noted cementing is difficult and there is a lack of requirements to verify the quality of the cement job. They argued that simply observing cement returns at surface is inadequate. They believed the cement may slump or it may channel up the wellbore-casing annulus creating flow paths for water from the aquifer down the wellbore. The Skinners noted the majority of wells drilled in Section 16 did not have cement bond logs to verify the integrity of the production casing cement job. Existing bond logs showed to some degree poor cement jobs and potential flow paths for water into deeper formations.

The Skinners' witnesses acknowledged the primary purpose of surface casing is for well control but also argued that protection of freshwater aquifers should be considered when determining appropriate surface casing setting depths. They argued that in order to provide adequate protection, surface casing must be set below the aquifer. They added that the casing must be cemented to surface and the appropriate cement bond or evaluation logs administered to verify the cement job integrity.

The Skinners also expressed concern with the abandonment procedures used by Amax. They submitted that with time, corrosion of the production casing string may be a problem and, if serious enough, may cause holes in the casing and communication between the wellbore and aquifers. The Skinners stated that the wellbore should be plugged with cement from total depth to surface.

The Skinners expressed concerns with respect to the design and operation of the 10-16 battery. In particular, they argued that the vapour recovery unit (VRU) is not properly controlled and may lack capacity to meet production requirements. They stated that this lack of control or capacity may have caused some of the strong odours which they have experienced in the past. The Skinners argued there is a risk of damage during cold weather conditions to the plastic suction lines leading to the VRU and if produced gas is used for line heater fuel there is a risk of fugitive emissions created by the lack of a flame shut-down system on the line heater. The Skinners submitted that the drain lines from the VRU suction scrubber discharged onto the ground outside of the VRU building and that this is a potential source of odours and groundwater contaminants. They believed the ongoing problems with odours at the 10-16 battery would be exacerbated with additional production from more wells.

The Skinners had a particular concern about fires caused by the Amax operation. Over the last 14 years at least six fires have been caused by either the Sparky or the 10-16 batteries. This included a 30-acre fire in a stubble field in 1989, some 270 m from the dairy barn, caused by the 10-16 battery. The Skinners submitted that more recently the flare went out at the 10-16 battery and oil spewed out of

the stack, affecting some 23 acres of crop land. They stated that had the wind been blowing from the battery towards the dairy, there is no doubt that their cows, pasture and dairy barn would have been covered in oil. The Skinners stated the Sparky battery has a history of catching or causing fire. They contended that Amax does not have any effective equipment or an emergency plan to deal with a fire at the batteries, well sites or satellite facilities.

With respect to noise impacts, the Skinners submitted that what was once a quiet farmstead is now subject to the sounds of vehicle traffic, pumps, service rigs and drilling rigs. The sounds vary in pitch and intensity and they believed this causes increased stress in the herd. They conceded the 10-16 battery is not usually a major source of noise.

The Skinners contended the numerous pipeline breaks, fluid, oil and chemical spills, and the involuntary shut-down of some of the facilities has caused soil contamination. They stated that, given the local topography, the slough used to water livestock serves as a collection point for runoff within the Skinner bowl and thus receives any pollutants from various Amax facilities. They added that the remote sump used by Amax to contain drilling fluids is located near a spring that feeds a second livestock watering and fish pond. They were concerned that any contaminants in the runoff water would affect the health of the herd in the long term and should be considered a real risk to herd health.

The Skinners stated that prior to the relocation of the original main access road, the constant vehicle traffic caused the air to be contaminated with dust which detracted from outside activities, dirtied clothing and infiltrated the houses and buildings. The dust also became an irritant to the dairy herd. The Skinners agreed that since the relocation of the road, the dust problem had lessened considerably. However, they maintained that dust continues to be a problem during drilling and servicing operations.

The Skinners acknowledged that Amax had made some effort since 1990 to try and reduce emissions and minimize visual and noise impacts; however, they said that in the past Amax took a reactive approach to its operations and would only address a problem if the Skinners complained. Amax had not implemented effective approaches to addressing problems before they occur. As an example, they noted that when Amax added additional fire equipment to the 10-16 battery the operating staff were not trained to use the equipment. The Skinners contended that the risks caused by the present Amax operations cannot be permitted to continue nor can Amax be permitted to expand its operations since this would result in new sources of fugitive emissions, fires, explosions, noise, safety hazards and other impacts.

2.2.1.2 Views Of Amax

Amax submitted that it had drilling programs for the Dina in each of the years 1986, 1987 and 1988, with the majority of the wells being drilled in 1987. A total of 22 wells were drilled on Section 16 during this period. During drilling, generally only one rig was used and the rig would remain on Section 16 for the duration of the drilling program or portion of the program for which it was contracted. The drilling programs provided for a combination of straight and deviated wellbores having a depth of approximately 850 m. Amax said the wells were drilled with fresh water to a depth of approximately 600 m at which point the drilling contractor would change to a standard gel-chem mud system. It noted that no lost circulation or well control problems had been experienced. Amax stated that drilling records confirm that invert drilling mud was used in drilling four wells, the most recent use being the drilling at the 10-16 pad location.

Amax said that prior to drilling the well, the surface casing design and projected setting depth are determined in accordance with the Oil and Gas Conservation Regulations. Surface casing is set at approximately 90 to 95 m (10 per cent of total depth) and is cemented full length to surface. Amax noted the Hayter Dina A Pool was initially drilled prior to 1981 and consequently qualifies for an exemption from running deeper surface casing. Amax volunteered to extend the surface casing at new Dina wells to a depth of 130 m.

Amax stated that production casing is run to total depth and is cemented full length to surface. To obtain a good cement job on the production casing, centralizers are placed along its length to ensure the casing is properly centred in the hole. During the placement of the cement, the production casing is sometimes rotated or reciprocated to reduce the potential of channelling in the cement. In addition, fluids displaced to surface during the cementing job are monitored to confirm that cement returns are obtained and maintained at surface. Once cement returns are maintained at surface it is concluded that the production casing is adequately cemented and all formations are isolated behind the casing. If cement returns are not maintained, a cement bond or cement top locating log is run in the wellbore to the top of the cement and to determine whether there are exposed formations or aquifers. The appropriate ERCB Area Office is contacted to determine the need for a remedial cement job to isolate any open formation or aquifers.

Amax indicated it prefers to not do any remedial cementing unless required, favouring instead to monitor the well during its productive life and then do remedial cementing at the point of abandonment. This approach avoids perforating the casing and eliminates the potential for communication between the wellbore and outside formations through the perforations. Amax confirmed that as long as cement returns are maintained at surface, cement bond logs are not routinely run unless requested by the ERCB. Also, cement bond logs are typically not run on the surface casing. Amax said the purpose of the surface casing is predominately for well control and that the cementing of the production casing provides for adequate protection for the freshwater aquifers.

With respect to well abandonment, Amax said that it had not abandoned many wells in Section 16, but its procedure would continue to be to set a plug above the perforations and pressure test to confirm the plug is holding. The wellbore would be then filled with corrosion inhibited freshwater, a second plug placed at surface, the casing cut-off one meter below ground level and a steel cap welded in place.

Amax stated that it was converting all of the Dina wells in Section 16 to electrically-driven, progressive cavity screw pumps. With this conversion it would soon have all of the noisier hydraulic-powered units removed from service. All the wells are equipped with high pressure emergency shut-down switches. The production from the wells is flow-lined either through satellite test facilities or directly to the 10-16 battery. It contended that the only potential source of H_2S emissions from the wells would be the stuffing box that seals the pump rod. If properly maintained, leaks would be relatively rare and to date this has not been a problem at the wells.

Amax submitted that it drilled its Section 16 wells from multiple well pad locations as opposed to single well locations because this reduces surface impacts. Pad drilling requires less land for drilling and production operations, allows for fewer access roads and pipeline right-of-ways and ultimately less area will have to be reclaimed. It stated that it has endeavoured to keep well locations clean and to reclaim any oil or salt-water spill areas. It submitted that it had relocated its main access road to the wells and batteries in order to reduce vehicle activity at the Skinner farm. Amax submitted its proposal for the continued operation of the wells, the battery and the additional wells would allow the two

industries to coexist and co-develop with minimal impact on each other. That proposal is discussed in greater detail in Section 4 of the report.

Amax stated it operates three satellite test facilities on Section 16 for Dina oil production. Each satellite has a production manifold that allows for production from individual wells to be diverted from the group production flowline to the test separation facilities at the satellite. This provides for measurement of oil, gas and water from each of the wells. It submitted that each satellite test separator is equipped with high and low pressure and high level shut-down switches that will shut the separator down in the event of a satellite upset. The separators are also equipped with pressure relief valves that are connected to tankage. The pressure settings of the relief valves are set higher than the shut-down settings on the separators and the wells. This prevents high pressure from the separators and wells from opening the relief valves to the tanks and emitting fluids or fugitive odours. Amax submitted there has been no instance of the relief valves opening at the satellite facilities.

Amax described the main components of the 10-16 battery to be the free-water knockout, the line heater, treater, two test separators, oil storage facilities and a VRU. It submitted that the 10-16 battery was designed with good engineering principals and with consideration for the environment, health and safety of people, and livestock in the area.

Amax said that due to numerous H_2S and SO_2 emissions from its 10-16 battery since 1987, it chose to conduct a facility review of the battery and to implement measures to minimize or eliminate the emission problem. This included significant changes to improve the storage tank VRU and the battery. These measures are detailed in Appendix A.

Amax proposed a 24-point plan for the continued operation of the 10-16 battery and the additional well developments. These points are listed in Appendix B of the report.

Amax further described in some detail its facilities and operations at the 10-16 battery. These are summarized in Appendix C of the report.

Amax submitted that although the 10-16 battery is fully equipped with sensing devices, some of which include detection and shut-down systems, the key to continued safe and successful operation of the 10-16 battery is a rigorous maintenance schedule and conscientious operating. It stated that the operation of the 10-16 battery, test satellites and wells is conducted by at least two persons on a daily basis and it has in place a comprehensive check list and maintenance program. It further submitted that the design of the facilities incorporates all practical measures to reduce or eliminate emissions and this together with its checklist and maintenance program goes well beyond normal industry practice and exceeds many of the requirements of the Oil and Gas Conservation Act and Regulations.

Amax acknowledged the Skinners' concerns with respect to odours, fire, traffic, emissions and contamination of groundwater that may result from the 10-16 battery. It stated that in the past it responded to the concerns by modifying portions of the 10-16 battery that caused the problems. It listed those measures to address the Skinners' concerns (Appendix A) and believed that they were adequate and appropriate to correct the problems.

2.2.1.3 Views Of The Board

The Board has considered the drilling and completion practices of Ladd and Amax on the wells they have drilled to date on Section 16. The Board is of the view that drilling procedures, surface casing setting depths and cementing programs were carried out by Ladd and Amax in a manner consistent with the applicable regulatory guidelines. The Board does not believe there is a measurable risk of contamination of aquifers on Section 16 because of the required surface casing setting depth for the wells. The Board agrees with Amax that the primary purpose of surface casing is for well control during the drilling of the well, and that the full length cementing of production casing will adequately protect local subsurface aquifers. The Board is not convinced by the opinions of the witnesses for the Skinners that uncemented channels down the wellbore around the production casing serve as significant conduits for groundwater flow from shallow to deeper aquifers. Notwithstanding, given the intensity of drilling in this area it may be prudent to extend the surface casing below deeper freshwater aquifers as a supplementary measure of precaution. The Board believes the current practice of cementing the entire production casing is generally adequate protection against contamination of aquifers; however, it would accept Amax's proposal to set surface casing to a depth of 130 m as an extra precautionary measure.

The Board believes that well cementing operations, if well planned and executed, will ensure isolation and coverage of all zones of concern. The Board is satisfied that monitoring cement returns during pumping operations is a suitable indicator of the success of the cementing operations. If complete cement returns are not obtained, indicating the occurrence of lost circulation while displacing cement, or if the cement level slumps back down the hole after completing pumping operations, the Board requires remedial measures be taken. These measures are based on an assessment of the cement job which very often includes a cement bond log, or temperature profile survey to determine presence or non-presence of cement. While the Board often requests bond logs in such assessments, the Board does not believe that bond logs should be a routine requirement for wells in Section 16, as suggested by witnesses for the Skinners.

The Board acknowledges the concern expressed by the Skinners on cased hole abandonment procedures used by Amax. Plugging or isolating the producing section of a cased wellbore with cement, displacing the cased wellbore to inhibited water and capping the well below ground level with a welded steel plate or cement is standard, acceptable abandonment procedure and meets present Board requirements. This has been the requirement for many years. The Board is satisfied that the well abandonment procedures proposed by Amax meet the present requirements and does not believe corrosion represents a material risk of contamination of freshwater aquifers.

The Board is concerned with regard to the extent of usage by Amax of invert (diesel-based) drilling muds. The Board would normally expect, particularly given the sensitivity of the dairy farm to both surface and subsurface contamination of water supplies, that such invert muds would be used rarely, if ever, and further that much closer, hands-on supervision of contractors during the use of invert muds would be carried out by the company. The Board will require Amax to provide the Skinners and the ERCB Wainwright area office with the details of any invert mud systems it would propose to use in future drilling operations on Section 16 prior to the commencement of drilling.

With regard to past day-to-day well site maintenance, the Board is of the opinion that, based in part on the conditions observed during the site visit, general housekeeping has likely been minimal at many well sites. The Board expects all operators to maintain their well sites in good condition, with

adequate fencing, proper weed control, and minimal waste materials left on site. Even more diligent attention would be expected at any operation where the potential for conflict between the oil and gas industry and the agricultural industry is high. The Board saw little evidence that such standards had been met in the past at the Amax operations in Section 16. The Board has a similar concern with the past operation and maintenance of the central sump for drilling fluids.

With respect to past operating practices, the Board is of the view that Amax did not consistently operate its wells, gathering and testing systems, or the batteries located within Section 16 in accordance with acceptable standards. While the Board concurs with the view of the Skinners that significant improvements appear to have been made in operations, these do not appear to have been made in a proactive manner, but rather only after significant negative impacts, including odours, spills, fires, dust, and noise have occurred. It is the Board's view that the deterioration in the relationship between the company and the landowners over the past four years is a direct result of inaction by the company as well as its insensitivity to the incremental effects of ever-increasing levels of activity on both the Skinner quality of life and on their farming operations. For example, the delay in the decision to relocate the access road away from the family farm until after a significant increase in drilling activity had occurred clearly demonstrates a tremendous insensitivity to the potential impact of intensive oil and gas activity on rural lifestyles.

At the hearing, Amax made a number of commitments with regard to ongoing improvements in its operating practices. The Board accepts that improvements already made by Amax have significantly reduced impacts on the Skinners, and accepts that the proposals for future action, if carried out, should result in further improvements. The Board does continue to have concerns with some aspects of the 10-16 battery and its operation. These include:

- the proximity of the battery to an intense agricultural operation in the Skinners' farmyard, particularly since the battery and the dairy both operate 24 hours per day,
- the continued potential for fire, atmospheric emissions and liquid spills from the battery,
- the nuisance and visual impact of the flare on the Skinners, and
- the impact to surface waters and soil resulting from contamination from the battery and associated activities.

2.2.2 Dairy Farm Operating Practices

In assessing the potential impacts of the Amax oil operations on the Skinner dairy operations the Board believes it is also necessary to recognize and consider dairy management practices in general as well as the actual Skinner operation. The Board heard considerable evidence from witnesses for both sides to the effect that modern dairy operations are complex, requiring a high level of management, and are subject to a number of normal operational upsets routinely associated with intensive agricultural operations. To adequately appreciate the potential impacts of the Amax oil operations on the Skinner dairy operations, it is necessary that the Board be able to appreciate the degree of normal variability which could occur in a dairy operation (e.g. in milk production, herd health, etc.) in the absence of nearby oil and gas operations.

2.2.2.1 Views Of The Skinners

The Skinners are convinced that the Amax operation affected the health of their dairy herd and resulted in a reduction in milk production. The Skinners submitted they have been on an owner-sampler Dairy Herd Improvement (DHI) Program from 1980 to 1987. In March 1987, they became involved in the supervised DHI Program. The difference between the two programs is that under the latter program, a DHI technician collects the data rather than the dairyman. It was the Skinners' contention that data collected under both programs were equally valid and reflective of the milk production of their herd.

The Skinners attempted to maintain a "closed" herd in that they tried to produce all their own replacement cows to improve the genetic quality of the herd. They have been quite successful, especially in maintaining a very low calf mortality rate which results in the high availability of replacement heifers for their herd. Only between November of 1988 and January 1989 was it necessary to purchase replacement milk cows in order for the herd to keep milk production at the quota level required. The Skinners submitted evidence that the need to purchase replacement cows was in response to emissions from the 10-16 battery which had affected the milk production of their herd.

The Skinners stated that they did all their own herd health, artificial insemination and pregnancy examinations on their cows. They consult with local veterinarians as necessary. They believed that their training and experience allowed them to perform these tasks very successfully. They contended that it was not necessary to have a veterinarian provide a formal herd health service due to their constant contact with the animals and thus their ability to respond in a timely fashion to any observed health problems.

The Skinners produce all their own cereal grain and cereal silage used for feed and believed that their feeding program provides for proper nutrition of their dairy animals. They stated that alfalfa pellets are purchased off-farm. The feeding program has remained virtually unchanged except for the introduction of canola meal as a protein supplement in 1988, and the addition of anhydrous ammonia to the silage in 1985. Feed is sampled annually and analyzed by Alberta Agriculture Soil and Feed Testing Laboratory. Nutritional consultation is also provided by Alberta Agriculture and its recommendations are followed by the Skinners in formulating the various feed rations.

The Skinners noted that while the Amax oilfield operations virtually surround the dairy operation, the normal operations of the dairy have not been impaired by the physical location of Amax facilities except for a well site containing four directionally drilled wells located in an area previously used by the Skinners as a calf pasture (Figure 2). The Skinners stated that the site could no longer be used as pasture because it was unsafe, citing poor fencing and inadequately installed or maintained cattle-guards around the wellhead pumping mechanisms.

The Skinners stated that the milking barn utilizes a slurry manure system. The barn floor is scraped twice daily with a skid loader. The manure is pumped into a lagoon located just north-east of the barn and the lagoon is typically emptied annually, usually in the spring, onto the cultivated lands near the yard. The remaining facilities utilize a solid manure system whereby either a pack of manure and straw is built-up over the winter or in the case of the calf barn, the solid manure is removed daily from the barn onto a pile. The solid manure is also spread onto the surrounding cultivated fields. The only time that odours are detected from the manure is during the one or two days a year during which the liquid manure lagoon is being emptied. They submitted that the manure lagoon did not emit H_2S except while being emptied and then only at very low concentrations.

2.2.2.2 Views Of Amax

Amax acknowledged that the Skinners' farming operations were generally well managed and that their record keeping contributed to the Skinners' management capability. It questioned however whether the health problems of the herd could be attributed to the oil field activity.

Amax contended that for the purposes of the hearing, only the milk production data accumulated under the supervised DHI program should be used. This independent DHI data could be verified for accuracy and consistency.

Amax acknowledged that the Skinners were very successful in raising their calves. The very low calf mortality was attributed both to the management abilities of the Skinners and the "state-of-the-art" calf barn.

Amax contended that, since the Skinners did not utilize a formal herd health program under the regular and direct supervision of a veterinarian, the herd health data and interpretations presented by the Skinners were open to question. Amax acknowledged that while herd health, including artificial insemination and pregnancy checks, was being adequately monitored by the Skinners, the Skinners did not have the appropriate background to adequately diagnose or respond to non-routine herd health concerns. Amax stated that the health symptoms observed were not specific. Since a veterinarian was involved infrequently in the herd health problems experienced by the Skinners, key information or analyses did not exist.

Amax argued that the farming operation also had an impact on the environment of the Skinner bowl. They suggested that the lagoon holding manure from the milking barn, and located in the farmyard, could contribute to H_2S concentrations and therefore odours in the farmyard.

Amax also questioned the Skinners' management of the nutritional content of their feeds. They noted that the nutritional recommendation provided to the Skinners by Alberta Agriculture was based upon very few actual feed samples. Thus, the recommendations were based upon area averages for feed quality. Such an approach would not recognize the normal annual variability in feed quality or the change in feed quality over the year.

2.2.2.3 Views Of The Board

The Board notes that all parties agree that the Skinner dairy operations are well run and managed and it concurs with this view. With regard to the Owner-Sampler DHI data provided by the Skinners, the Board accepts the Skinners' argument that their data should be as reliable as supervised DHI data. The Board is also willing to accept the data provided by the Skinners with regard to general health of their herd and pregnancy rates.

The issue of H_2S sources from the dairy operations is addressed in Section 2.3.1.4.

2.3 Environmental Impacts

2.3.1 Atmospheric Impacts

2.3.1.1 Views Of The Skinners

The Skinners contended that emissions from the 10-16 battery were having an adverse effect on their herd health and may represent a health risk to the families. The Skinners did not believe that Amax's air quality monitoring program was particularly effective or provided an accurate evaluation of the air quality in the Skinner bowl. They contended that the frequency and level of H_2S emissions have been greater in the past than was recorded by the Amax air monitoring units. They noted the role wind direction plays, since the monitor will record an emission only if it is downwind from the source. Further, the averaging of the emissions over time fails to recognize the high concentrations that may exist for short durations at any given time. They stated some of the monitored hourly average emissions exceeded the permissible ambient levels established by the Province[1]. Both the exceedances and the peak levels of emissions caused concern for their effects on the Skinner families and the dairy herd.

The Skinners submitted that during the period of 1 - 2 August 1991, they conducted a testing program at the 10-16 battery to measure and identify potential sources of odours in the ambient air. Samples were taken from the flare stack, treater stacks and one of the produced water tanks.

Analysis of samples taken from the flare tip showed only reduced sulphur with H_2S, carbonyl sulphide (COS), and carbon disulphide (CS_2) detected. Analysis of the gas collected from the downwash of the flame did not show any reduced sulphur. Analysis of the inlet gas to the flare showed the H_2S concentration varied from 1.8 to 3.2 mole per cent during the sampling period.

Samples for reduced sulphur from each of the treater stacks were taken under two different conditions. With the units operating and the flame lit, no reduced sulphurs were detected. With the unit operating but the flame unlit, H_2S averages of 190 parts per million (ppm) for the south treater stack and 107 ppm for the north treater stack were recorded. The Skinners contended that this was significant because the pilot flame relight did not function 100 per cent of the time.

The Skinners' analysis of the gas vapour in the enclosed produced water storage tank showed H_2S concentrations of 12 mole per cent were possible if the tank was leaking or if the thief hatch was open.

The Skinners stated they had experienced ongoing odours from Amax's batteries, wells and facilities since 1987. They indicated that the odours were mainly from the 10-16 battery and have ranged from light petroleum smells to very strong sulphur smells. The Skinners submitted a chronology of some of the odour events:

- 1988 - 1989, Amax operators were opening tanks lids to measure contents. Coincidental with these odour episodes, health effects were noted in the Skinner dairy herd, such as pink eye and clouded corneas, with the highest occurrence of corneal opacity during the 1989-90 winter.

[1]Alberta Clean Air Act & Regulations

- April 1990, Skinners complained about odours to the ERCB and started documenting odour occurrences. Ten odour events were recorded by the Skinners over the next 4 months.

- August 1990, the air monitoring trailer was installed. Five odour events were recorded by the Skinners.

- September 1990, five odour events were recorded by the Skinners and the monitor showed several infractions.

- October 1990, eight odour events were recorded by the Skinners. The most severe occurred on 11 October 1990. The flare blew out, the odours were strong and they accumulated in the bottom of the calf pasture.

- December 1990, black smoke, resulting from a VRU upset, was sucked into the milking barn by its ventilation system.

- 20 December 1990 to 16 January 1991, persistent strong odours occurred due to extremely cold weather and related malfunctions at the 10-16 battery. The odours were not recorded by the monitor but were noticed by the Skinners in the vicinity of the cow barn and the area where dry cows and heifers were kept. Twenty odour events were recorded by the Skinners for the months of December and January.

- February 1991 to June 1991, nine odour events were recorded by the Skinners.

- July 1991 to January 1992, fourteen odour events were recorded by the Skinners.

The Skinners conceded that the emissions from the treater and line heater stacks at the 10-16 battery now meet the current SO_2 guidelines. However, they did not believe that the proposed expansion would allow the 10-16 battery to continue to meet the maximum permissible SO_2 emission levels.

The Skinners submitted that during operational upsets they believed that the H_2S concentrations would be sufficient to cause odours but would not constitute a health hazard. The separation distance between the battery and the cow pasture should be increased, however, to allow for greater opportunity for dispersion of the H_2S and to thereby lower concentrations which may be present at the farm.

2.3.1.2 Views Of Amax

Amax submitted it had monitored wind direction, SO_2 and H_2S concentrations at three sites located near the 10-16 battery during the months of August, September, October and November 1990. Locations of the monitoring sites with respect to the battery, neighbouring oil wells and the Skinner dairy farm are shown in Figure 2. The data were analyzed to assess the general behaviour of SO_2 and H_2S emissions in the area.

With respect to SO_2, Amax submitted that during prevailing south winds, SO_2 readings were recorded by the monitor about 45 per cent of the time. This indicated that an SO_2 source was located to the south of Site A. Amax concluded that the source was the flare at the 10-16 battery which incinerates H_2S gas to SO_2. During prevailing south-east winds there were SO_2 observations at Site B about

10 per cent of the time and at Site C about 5 per cent of the time. It submitted that the SO_2 source of these readings was the Sparky battery located 650 m south-east of the monitor. During prevailing north-westerly winds Amax observed occasional SO_2 observations. Amax contended these SO_2 readings were from other local oil and gas production facilities not operated by Amax. The maximum hourly average SO_2 concentrations observed at Sites A, B and C were 90, 30 and 20 parts per billion (ppb), respectively. The Provincial maximum permissible hourly average concentration is 170 ppb.

With regard to H_2S, Amax submitted that there were several potential sources of H_2S in the area of the 10-16 battery and Skinner farm. It stated that H_2S observations at Site A tended to occur under both southerly and north-westerly wind conditions and indicated that the battery and the dairy farm, which lie in these general areas, are both possible H_2S sources. Amax added that high H_2S concentrations occurred at Site B most frequently during times which were characterized by north-west winds from the area of the dairy farm. Amax submitted that at Site C, H_2S observations were also recorded most frequently when winds were from the general area of the Skinners' milking barn. It stated that other H_2S sources, in this case well sites, also exist in directions north-north-east, east-south-east, south and west-south-west of Site B.

Amax observed that H_2S concentrations exceeded the Provincial maximum permissible hourly average concentration of 10 ppb on eight occasions, with a maximum H_2S concentration recorded of 57 ppb. Amax submitted that concentrations of this magnitude may constitute a nuisance but would not have any adverse health effects. It added that any nuisance effect should have since been ameliorated by its program to reduce fugitive emissions.

Amax concluded from a further analysis of the data that observations of H_2S at Site A were most frequent during day time hours. They concluded that the sources likely resulted from activities associated with upgrading of battery facilities. This upgrading was part of its program to reduce fugitive emissions. It also concluded that the observations of H_2S at Site C showed a pronounced diurnal variation, occurring most frequently during morning (0700 - 0900 MST) and evening (1800 - 2000 MST), and therefore possibly were related to activities of the dairy operations.

Additional air quality data were collected by Amax from January to July 1991 at an air quality monitoring trailer located 150 m north of the 10-16 battery and 300 m south of the midpoint of the Skinners' dairy farm. Amax submitted solution gas is combusted at the 10-16 battery for the purpose of heating oil and the combustion products are vented through stacks. It added if all the H_2S is combusted then the stack effluents will contain SO_2 but no H_2S. It further added if there is incomplete combustion, stack effluents will contain H_2S. Amax concluded that effluents from the stacks associated with the 10-16 battery are the only local source of SO_2.

Amax submitted that the observed median values of 10 ppb of SO_2 and 1 ppb H_2S measured during this period were very small. Elevated H_2S and SO_2 concentrations were observed together about 18 per cent of the time when the wind was from the south. The fact that SO_2 and H_2S were observed together suggested that the combustion of solution gas was not always 100 per cent effective. Maximum H_2S concentrations of 38 and 32 ppb were observed when winds were from the south-southeast and south, respectively, the general direction of the 10-16 battery. Maximum H_2S concentrations observed at the farm under these conditions were 7 ppb. A maximum hourly average SO_2 concentration of 330 ppb was recorded at the monitoring trailer, which was calculated to decline to 40 ppb at the dairy farm.

Amax submitted that high concentrations of SO_2 tended to be associated with moderately high wind speeds and that these SO_2 readings were generally associated with H_2S. It believed that the tendency for higher SO_2 readings to occur at high wind speeds is due to stack downwash, where the wind forces the emissions down the leeward side of the stacks. Because elevated H_2S concentrations occurred under both high and low wind speed conditions, Amax concluded that the H_2S originated from both ground based (e.g. fugitive emissions) and elevated sources (e.g. incomplete combustion within the stacks).

Amax conducted a study to determine if high wind speeds caused incomplete combustion. The study indicated that incomplete combustion is not a function of wind speed. It also considered incomplete combustion as a function of time of day. Incomplete combustion was observed about 50 per cent of the time during early morning hours and about 20 per cent of the time in the late afternoon.

Amax assessed the results of stack emission tests conducted at the 10-16 battery during the first part of September 1991 and confirmed that stack emissions are a source of H_2S due to incomplete combustion. Maximum H_2S concentrations at the dairy farm from the stacks were calculated to be about 11 per cent of those observed at the monitoring trailer due to the dispersion which occurs over the distance between the trailer and the farm.

Amax submitted surveys of emissions from the treater and the line heater stacks. Effluent from these stacks results from the combustion of solution gas which contains 4.24 mole per cent H_2S. The battery currently generates about 1300 cubic metres per day (m^3/d) of solution gas. Any solution gas which is not consumed as fuel in the treater is directed to the flare stack. Historically, solution gas production varied from 945 m^3/d to 2100 m^3/d and all of the gas was used in the treater and line-heater. Approximately 900 m^3/d of rural gas co-op natural gas is now purchased as fuel to supplement the treater fuel and for use as instrument gas.

Amax stated that treater stack emission parameters such as gas temperature, exit velocity and SO_2 flow rate depended upon whether one or both burners were operating. Amax estimated that SO_2 would be emitted at a rate of 1.08 kilograms per hour (kg/h) if one burner was operating continuously and assumed that emissions from the second burner would be similar. It also assumed that solution gas would be distributed evenly between the treater and the line heater. Amax concluded that this meant the line heater SO_2 emission rate would be 2.16 kg/h and the combined emissions from the treater and line heater stacks would be approximately 4.32 kg/h.

Amax noted that the stack exit velocities at the 10-16 battery were very small. When wind speed exceeds the exit velocity, stack effluent will be caught by vortices in the lee of the stack caused by this wind speed and directed toward the ground (downwash). The extent of downwash is a function of the ratio of wind speed to exit velocity. Amax stated that because exit velocities are small, downwash effects will be considerable. It believed that effluent from the treater and line heater stacks would be brought to the ground at wind speeds greater than 4.5 metres per second (m/s) (16 km/h). Under these conditions the emissions would act as a ground based source. This assumption was in agreement with the experience of the stack samplers who smelled SO_2 at heights well below stack top levels.

Amax calculated the SO_2 diffusion from the 10-16 battery assuming that the SO_2 was a ground based source. Estimates of ground level SO_2 concentrations suggested maximum SO_2 concentrations of about 300 ppb for wind speeds of 4.5 m/s. This value compared closely to the actual observed maximum hourly concentration of 330 ppb. Amax stated this close agreement supports the assumption that SO_2 stack emissions at the 10-16 battery act as a ground based source.

Amax submitted that the results of the dispersion calculations using Alberta Environment's STACKS 2 model predicted that hourly average ground level SO_2 concentrations resulting from flaring 945 m^3/d of solution gas should not exceed values of about 22 ppb, and that current operations of its 10-16 battery flare is consistent with the maintenance of desirable air quality. Amax concluded that past exceedances of Provincial air quality standards were the result of very low exit velocities from the stacks and that these exceedances should only occur in the vicinity of the battery. Amax stated that the stacks at the 10-16 battery would be upgraded to address the downwash problem (Appendix B).

On 15 July 1991, with prevailing winds from the direction of the dairy farm, Amax observed a maximum H_2S concentration of 7 ppb. As the monitoring trailer is some 300 m downwind from the dairy farm, Amax suggested that the H_2S concentration at the source could be significantly greater. Amax hypothesised that one source of H_2S could be the manure lagoon because of anaerobic decomposition of liquid manure. Findings of other studies have found concentrations of H_2S in excess of 1000 ppm to be occasionally associated with manure gases.

Amax contended that fugitive emissions from the 10-16 battery were well below Provincial standards and although it acknowledged that emissions have occurred, they have not presented a health risk to humans or animals. Amax concluded that its 10-16 battery was no longer a significant source of H_2S emissions. It suggested this is a result of efforts made in the previous months to reduce fugitive emissions at the 10-16 battery.

2.3.1.3 Views Of The Interveners

The Alberta Environmental Centre questioned the value of only measuring levels of SO_2 and H_2S when trying to determine possible affects from a sour oil development. Their concerns centred around the unknown behaviour and effects of complex mixtures of sulphur and hydrocarbon-based compounds.

2.3.1.4 Views Of The Board

The Board is of the view that the monitoring program carried out by Amax represented a reasonable effort to detect and record potential emissions of H_2S and SO_2 from the facilities. The Board also concurs that the levels of H_2S and SO_2 recorded by Amax were generally at a "nuisance" level and not high enough to represent a risk to life or health. The potential affect on the dairy herd health is discussed later in Section 2.3.4.

The Board also accepts the view of the Skinners that the family experienced strong odours that were not recorded on the monitoring devices. The Board does not believe that this was due to any failure of the monitor or monitoring program. Rather, the Board is of the view that a broad range of meterological conditions, when coupled with the fixed location of the monitoring points and the use of hourly average calculations would likely have resulted in some under-reporting of the recorded emissions experienced by the Skinners in both intensity and frequency.

The Board notes that Amax concluded that there was a correlation between its operations and elevated levels of H_2S and SO_2 at the monitoring points. The Board also accepts the evidence of the Skinners that several areas of the 10-16 battery represented potential sources of both reduced sulphur and SO_2. The Board is of the view that several factors associated with operation of the 10-16 battery were sources for the odour events noted by the Skinners. The Board accepts the Amax evidence that stack downwash was one potential source. Other historical sources were very likely to have included failures

in the VRU and, in particular, the frequent failure of the thief hatches on the produced water and oil storage tanks. The Board does not believe that the Skinner dairy farm operations, and in particular the dairy barn and manure storage lagoon, represented significant sources of H_2S. While the Board can accept the evidence that under certain conditions manure may produce significant concentrations of H_2S, the regular operations on the Skinner farm did not appear to create such conditions. For example, the lack of agitation and open-air storage of manure would strongly suggest that released levels of H_2S would be low.

Both Amax and the Skinners observed that there had been a reduction in detectable emissions at the dairy farm. This appears to have resulted from a number of improvements made at the battery. The Board accepts the commitments made by Amax to continue to look for other areas where improvements can be made, such as stack redesign. The Board accepts the view of both parties that the current and proposed changes will allow Amax to meet the existing air quality standards at current levels of solution gas production. The Board is of the view that should permission be granted to continue operation of the 10-16 battery, Amax will be expected to respond immediately and effectively to detectable odour incidents, whether or not the levels measured at the Skinner farm are below Provincial standards. The Board will also expect Amax to proactively initiate all steps needed to end excess emissions, including facility shutdown, when it is not possible to immediately implement the appropriate technical improvements. Finally, the Board will expect Amax, in discussion with the Skinners and ERCB field staff, to review their air quality monitoring program. Any future program will be required to be sufficient to provide an early indication of possible odour events or other exceedances within the Skinner farmstead. The Board will also review, with Alberta Environment, the parameters which should be measured.

2.3.2 Subsurface Impacts

2.3.2.1 Views of the Skinners

The Skinners estimated they use about 5000 gallons per day (gpd) of water from the three wells that currently supply the dairy. They expressed concern regarding the impacts that the existing oilfield operations may have had on groundwater quantity and quality, and the potential adverse impacts of continued and expanded oilfield activity.

With respect to water quantity, the Skinners argued that the drop in their water well levels could not be attributed to their use of the aquifers or to climatic conditions, but rather was caused by the drilling and completion of oil wells through these aquifers which created flow paths which allowed the water to drain from the upper aquifers into lower formations. Calculations of relative pressures and pressure gradients were presented to reinforce the theory that it was possible to have this drainage occurring.

Witnesses for the Skinners argued that groundwater quality had also been adversely affected by other oilfield activity. They stated that with fluids such as oil and water which do not readily mix, the oil can move in directions different than the regional or local groundwater flow. Consultants for the Skinners argued that plumes of pollution caused by oilfield activity could be migrating towards their water wells and cited elevated levels of chlorides in the 8-16 water well as evidence. It was noted that chlorides are a good parameter to use as an indicator of groundwater pollution, in part because the concentrations of chlorides in the aquifers being used by the Skinners are very different than in the deeper aquifers and in the hydrocarbon bearing zones. The characteristics of chlorides include being very mobile in the soil-water or groundwater. The presence of total petroleum hydrocarbon (TPH) and

phenols in trace amounts in the Skinners' water wells was suggested to be further evidence that the water quality of their wells had been affected.

The Skinners argued that the surface clays below the farm site and oil facilities were not as impervious as Amax suggested. They submitted that the elevated levels of nitrates found in the slough were a result of calcium nitrate being used as a soil amendment on salt-water spills. In addition, they suggested potassium nitrate which was sometimes used as a component of a drilling fluid, was being displaced in the soil by sodium and calcium following salt-water spills and ensuing reclamation efforts, and was the source of elevated potassium levels in the slough.

2.3.2.2 Views Of Amax

Amax conducted tests in August 1991 on the seven water wells (Figure 2) located on the farm. Based on its monitoring at that time, it estimated a water use rate by the Skinners of about 3500 gpd and noted that the use of water fluctuates according to the number of animals on the farm and increases during the winter months. Amax agreed with the Skinners estimate of 5000 gpd as being within the likely range for water use rate. Amax argued that while water levels in the wells had dropped 1 to 5 m from those levels recorded in the water well drilling logs, this would be consistent with the continuous use of the aquifers by the Skinners. Based upon these results no appreciable lowering of the water table due to oil and gas activity had occurred. Amax did not believe it was responsible for the reduced water levels in the Skinner aquifers and submitted that the drilling of petroleum wells had never been shown to cause the de-watering of any aquifer in Alberta.

The effect of oilfield activity on groundwater quality was also addressed by Amax. Amax argued that based on water analysis done on one of the Skinner wells in 1972, which indicated a chloride level of 16 ppm, and tests done in 1991 which ranged from 3 to 14 ppm, that there was no change to the chloride levels. Because chlorides are so closely related to oilfield activity, this in its view indicated no impact on water quality resulting from oilfield activity. Amax suggested that the Skinner wells were on a hydrographic high and therefore the regional water flow was away from the wells. It argued that even if the Amax wells were causing groundwater pollution, the results would not show up at the Skinner wells.

Amax also argued that the area subsoil was primarily an impervious clay layer of some 4 to 30 m in thickness and that this clay layer prevents oil and salt-water spilled on or near surface from entering the groundwater system.

Amax indicated that although unlike chloride there were no baseline values for either TPH or phenols in the Skinner wells, the trace levels observed were in the range frequently encountered as background levels in east-central Alberta, and were likely naturally occurring. One sample did have phenols at a level about five times the detection limit and the value found was confirmed by re-analysing the sample. Amax could not explain this occurrence. Upon re-sampling this well, Amax found phenol levels were at or near the detection limit, similar to results obtained from other wells tested.

2.3.2.3 Views Of The Board

With regard to groundwater quantities, the Board notes that both parties agreed with the average annual groundwater volumes being used by the Skinners for both domestic and agricultural consumption. Both parties also concurred that draw down has occurred in these wells. After reviewing the evidence

provided by both parties, the Board accepts the Amax position as the most reasonable. Their witnesses contended that the observed degree of draw down can be explained by the relative difference between water withdrawal rates by the Skinners, discharge rates from the aquifer, and the recharge rates into the aquifers. The Board does not accept the hypothesis of the Skinners' witnesses that oil wells in the area provide a significant opportunity for downward migration of groundwater at the Skinner wells. Nor can the Board conclude that the drilling of additional oil wells, assuming existing regulations are met, would result in any material increased risk of adversely impacting groundwater quantity. Further, the Board does not accept the hypothesis of the Skinners' witnesses that reservoir pressure reductions as a result of oil production from the Sparky and Dina pools causes fluids such as groundwater from upper formations to migrate to those produced pools.

With regard to impacts on groundwater quality, the Board could not find any compelling evidence that the quality of water in the Skinner water wells had been negatively impacted by oil and gas activity. The lack of elevated chloride levels, which witnesses for both parties agreed would be an excellent tracer for oilfield pollution, was particularly notable. The Board has difficulty accepting the hypothesis of the Skinners' witness that phenols and petroleum hydrocarbons were detected in the Skinner water wells due to the migration of Dina and Sparky formation waters, while chloride levels, which were at much higher concentrations in the formation waters, were not elevated in any of the water wells tested.

While the Skinner water wells do not appear to have been negatively impacted by the Amax oil operations, the Board can appreciate the family's concern. The Board will require Amax to meet its commitment to develop an ongoing sampling program to continue to ensure the Skinners' well water and surface water quality remains high. The program will be developed in consultation with the Skinners and the ERCB in order to ensure that the sampling is effective and efficient. The Board will also initiate discussions with Alberta Environment to determine the need for research into methods for measuring low levels of organics such as petroleum hydrocarbons and phenols, and for establishing natural background levels of these compounds, particularly in the Provost area.

2.3.3 Surface Impacts

2.3.3.1 Views Of The Skinners

The Skinners submitted that they have incurred extensive agricultural and surface impacts over the years as a result of the Ladd and Amax operations on Section 16. They stated that the problems caused by the Amax facilities, wells, pipelines and contractors as they currently exist do not allow the Skinner dairy and families to reasonably coexist with the oil operations. They stated that in the past Amax took a reactive approach to its operations and would only address a problem if the Skinners complained. It was their view that there would always be unacceptable impacts from the 10-16 battery, satellites and related wells as long as they were operating in proximity to the dairy farm. Further, the Skinners believed it would be unlikely that Amax would be able to implement an effective proactive approach to addressing problems before they occur. They submitted that one or the other of the industries must be removed.

The Skinners stated that dust has been an ongoing problem resulting from oilfield traffic in and around the farm. They agreed that since the main Amax access road was relocated in 1990, the dust problem has improved although it recurs when activities such as well drilling and servicing take place. Since many of the wells and facilities are located near or within the Skinner bowl, dust commonly disperses throughout the area. The Skinners believed the dust has affected herd health.

The Skinners described numerous oil and salt-water spills that occurred as a result of facility upsets, poor operating practices or faulty materials and equipment. They stated the spills have had an adverse effect on soil quality, crop production, and surface and groundwater. The Skinners argued many of the wellheads on Section 16 leak, the Sparky pipelines have ruptured on several occasions, a salt-water tank at the 10-16 battery ruptured and released salt water for an extended period of time, spills have occurred from drilling and servicing operations and most of the spills from the oil operations have been covered up rather than properly reclaimed. They argued that elevated potassium and chloride levels found in their watering slough are the result of the numerous salt-water spills that have occurred from either Sparky or Dina produced water. They stated that it was clear from Amax's own evidence that oil and salt-water pollution has occurred on Section 16. They did not believe that the spills would cease to occur with the implementation of Amax's 24-point plan (Appendix B) for continued operations and development. They argued that additional wells and production could only increase the risk and occurrence of oil and salt-water spills.

The Skinners expressed concern with the open sump located at 9-16 and the potential contamination of the subsoil and groundwater from the drilling fluids. They submitted that the fluids should be removed from the sump and the sump reclaimed.

The Skinners submitted that when Amax prepared the surface location for Pad 1 in 1990, it did not notify them that it would remove a stand of aspen trees located near the 10-16 pad site until after the trees were pushed down. They were advised that the trees were removed to accommodate the borrow pit that was required for fill material and for future drilling operations. The Skinners rejected Amax's offer to replace the trees because they interpreted the offer as being conditional upon their agreement to withdraw any objections to the production of the Pad 1 wells. They also felt that as the area has now been levelled and stabilized, any further activities by Amax may only create more problems. The Skinners were inclined to let the natural vegetation re-establish itself at its own pace.

The Skinners believed that as a result of the operation of the five wells on Pad 1, the immediate area surrounding the pad, referred to as the calf pasture, has been rendered unusable for agricultural purposes. They contended that the area is continually disturbed because of periodic well service operations and the frequent attendance by Amax staff and contractors. They do not use the calf pasture area for its intended purpose as it is not possible to satisfactorily coordinate the operations of both land users. The heavy equipment and frequent vehicle traffic disturbs the land surface, thus further affecting their ability to use the area for agriculture.

Well service operations were described by the Skinners as a major source of disruption to the dairy operation and farm life. They stated that with over 30 wells on Section 16, there are service rigs and related vehicles continuously driving in and out of the area. They had particular concerns respecting the large number of service personnel. They stressed that it is unsettling to have strangers on their land on such a frequent basis.

The Skinners submitted that weed control around the Amax operations is poor. They described weed problems to exist at most of the well sites and specifically identified poor control at 14-16, 11D-16, 15B-16, 10C-16 and 11A-16. They stated that the weeds spread into the cultivated fields from the Amax well sites and facilities. The Skinners control weeds around the farmstead by applying a herbicide, however, the application of the herbicide must be timed to the budding stage of the weed or it will not be effective. After the application of the herbicide, the Skinners maintain control of weed

growth by mowing. They believed that Amax's control of weed growth by mechanical means could be effective only if it is rigorously employed and timed before the weeds go to seed.

A witness for the Skinners claimed to have detected the herbicide "Picloram" in water samples taken from the slough. It was pointed out that Amax had used this herbicide for weed control in 1987.

The Skinners described the fencing of some wells to be inadequate and that belt guards for some electric pumps are not in place. These problems pose a hazard to the cattle and, on some occasions, the lack of fencing and other oilfield activities has resulted in injury to cattle, particularly calves. They stated that in one case an animal had to be destroyed.

2.3.3.2 Views Of Amax

Amax submitted that in the past it had recognized and responded to any concerns expressed by the Skinners in a manner that would reduce or eliminate surface impacts caused by its operations. It stated that it had endeavoured, to the best of its ability, to correct the problems as they occurred. It also stated that its 24-point plan (Appendix B) for continued operation of the battery and development of the Dina takes into consideration the concerns that the Skinners have expressed in their submissions to the Board. The concerns that it responded to or has addressed in its plan include those related to excess traffic and dust from its access roads, soil degradation, oil and salt-water spills, excess tree removal, tank and pipeline ruptures, sterilization of lands for agricultural uses and problems caused by service operations.

To address the traffic, safety and dust problems from the original access route, Amax relocated its main access road to the 10-16 battery and nearby facilities in 1990. The original main access road entered the section from the west side and passed by all Skinner residences and farm buildings. A new road was constructed that entered the section from the south, bypassing the residences and dairy farm. This effectively eliminated most of the traffic problems caused by the old road, significantly reduced the dust conditions in the Skinner bowl and provided a greater degree of safety for livestock and people in the Skinner farmstead area.

Amax stated that throughout its operations in the Hayter Field it has modified or replaced certain of its facilities that have caused spill problems. Amax also retained the services of soils and site reclamation consultants to ensure that spill locations are fully reclaimed. It believed that the incidence of spills has been reduced considerably in recent years as a result of these efforts. Amax discussed several pipeline breaks that had caused salt-water spills in the past. Amax stated that the troublesome lines were related to the Sparky system, and that the Sparky lines had been replaced with internally lined pipe to limit salt-water corrosion. It stated that all the Dina pipelines were originally installed with internal liners and, to date, have not experienced corrosion problems. In addition, cathodic protection has been installed on all pipelines in order to minimize corrosion. Amax also replaced a ruptured underground salt-water tank located at the 10-16 battery. To reduce both the incidence of leaking and noise from hydraulic lines and pumps, Amax changed over all of its hydraulic powered well pumps to electric power. Its operators also conduct a daily visual check of the wells, stuffing boxes and other potential spill sources.

With respect to its drilling sump located at 9-16, Amax stated that it is currently unused although it planned on utilizing the sump during the drilling of future wells. It did not believe that the sump created an undue environmental hazard as the drilling fluids did not contain invert materials and the

subsoil is comprised of a clay till that effectively contains the fluids in the pit. A fence is located around the sump to prevent cattle from entering.

Amax submitted that it has specific procedures in place with respect to reclamation of oil and salt-water spills and it disputed the Skinners claims of large quantities of salt water being discharged as a result of tank and pipeline ruptures. For example, based on its analysis of soil samples from immediately around the 10-16 underground tank, Amax calculated that approximately 0.5 m^3 salt water had been released to the sub-soil from the rupture. It identified several oil and salt-water spills that have been under reclamation since the spills occurred in the early 1980s. Oil spills occurred at 2-16, 6-16 and at the 10-16 battery (oil spray). Salt-water spill sites are located at 1-16, 2-16, 4-15, 6-16, 7-16, 8-16, 10-9 (2 spills) and 10-16 (tank rupture and spills around wellheads).

Amax submitted that the results of its spill reclamation program has shown a favourable return to previous soil quality and productivity at most of the spill locations, although many of the sites will require continued reclamation. The 7A-16 site in particular has not shown a reduction in areal extent or a return to normal conditions.

Amax noted that there was a question as to its right to remove a stand of aspen trees that was located on 10-16 for the purpose of obtaining fill material for construction of its 10-16 well pad (Pad 1, Figure 2). It believed that it had the right pursuant to a surface lease agreement with the Skinners. Notwithstanding that belief, it stated that it had offered to replace the stand of trees and is still prepared to do so. Amax argued that it did not intend to make the replacement of the trees conditional upon the Skinners' approval of the production of the four wells that were drilled from that site.

With respect to the concerns regarding the impacts from service operations, Amax stated that it services its wells during daylight working hours avoiding noise at night, uses methods that minimize odours, including the use of sweet completion fluid and closed tanks for swabbing and endeavours to keep noise from the service rigs to a minimum. It stated that each of the Dina wells on Section 16 requires a service operation approximately once every 12 to 18 months and the operation takes from six hours to two days to complete.

Amax did not believe that its service operations would effectively prevent the agricultural use of the land in the vicinity of the five wells on Pad 1. In the future, due to the short duration of the service operations, the service rig would be situated on a gravel pad and the fence surrounding the pad would be reduced in size. Amax believed this would allow the Skinners to use most of the area to pasture their calves as they have done in the past. It also stated that it would coordinate its service operations with the Skinners to further reduce any conflicts with the dairy operations.

Amax submitted that it has not used chemical weed control on any of its battery or well sites since 1987. Mechanical means are now used to control weed growth and will continue to be used. It did not believe that the alleged presence of the herbicide Picloram in the Skinners' slough was a result of its chemical weed control in 1987, because Picloram will rapidly decay in the presence of oxygen and light and is not a persistent chemical in water. It stated that its analysis of the Skinner slough showed no evidence of Picloram.

In response to a concern raised by witnesses for the Skinners that the slough had elevated nitrate concentrations, Amax said that such levels of nitrates are expected in a slough with considerable

biological activity. Further, potassium is a natural component of salts and will eventually find its way into the slough. Amax concluded that any changes or alterations in the water quality of the slough is not attributable to petroleum activity. It further stated that it did not find any indication of chlorides, sulfides, or petroleum hydrocarbons in the slough attributable to petroleum activity.

2.3.3.3 Views Of The Interveners

The Alberta Environmental Centre expressed concern respecting the affects of the Amax operations on soil quality on the Skinner farm and the impact of oil and gas operations on soil quality throughout the Province. The impacts that it identified were soil degradation, as a result of soil compaction, and contamination caused by oil and salt-water spills. Soil compaction results from the use of heavy vehicles and machines on the land. Compaction remoulds the soil and destroys soil structure thus affecting the hydrologic properties of the soil, moisture retention and ability of plant roots to penetrate the soil. It stated that salt-water spills affect the soil by dispersing clay particles which in turn changes soil structure and decreases water infiltration. Oil spills cause water repellency that prevents water infiltration and reduces aggregate stability within the soil. They suggested that Amax should include soil and water resource planning in designing its facilities, cause minimal disturbance to the land surface and immediately reclaim areas that have been disturbed or polluted.

2.3.3.4 Views Of The Board

In the Board's view, the past operating practices of Amax and Ladd were lax and generally reactive. Until recently, Amax appeared to show little sensitivity in responding to the concerns raised by the Skinners regarding the oil activity on their farm. It was Amax's position that its more recent operational improvements and new commitments (Appendix B) would deal with most of the Skinners' surface impact concerns. The Board agrees that many improvements have been made and changes such as the use of electrically-driven screw pumps will reduce noise and other impacts. Similar improvements in other operational areas were acknowledged by the Skinners. However, the Board accepts the view by the Skinners that working relationships will be difficult to mend given the lack of trust between the parties.

The Board accepts the Skinners' contention that, even with relocation of the primary access road, some ongoing impacts from the dust and noise will be associated with these operations particularly within the Skinner bowl.

The Board agrees with the position of the Skinners that both salt-water and oil spills have occurred frequently at the Amax operations. Of the two, salt-water spills appear to have had the greater impact on soil fertility. In general, cleanup of salt-water spills appears to have been initiated promptly. The improvements made by Amax in the quality and type of pipe used to reduce corrosion will likely reduce spill frequency. A more aggressive approach to salt-water spill cleanup may be appropriate. This is particularly important if spill frequencies and/or volumes remain high. The Board will instruct ERCB field staff to review this possibility with Amax.

Oil spills, particularly at the 10-16 battery, although less frequent than salt-water spills, are also of concern to the Board because of the past magnitude of the spills, the risk of fire and the associated health and safety risks. On at least two occasions liquids have sprayed from the 10-16 battery flare stack. In one case, the oil ignited and burned a portion of the adjoining field. The proximity of the Skinners' farm buildings and dwellings to the 10-16 battery make similar occurrences unacceptable.

The Board does not believe sufficient diligence has been shown to provide confidence that this could not occur again.

Both parties discussed at length the impact of surface runoff from spills and leaks on water quality in the slough. The Board does not believe serious degradation of surface water quality has as yet occurred. The Board supports the concern of the Skinners that the quality and quantity of their water supply must be protected. The Board believes that without adequate mitigative measures, the ongoing loss of oilfield-associated fluids could eventually threaten surface water quality. At particular risk is the large slough which serves as an important source of water in the summer for the Skinner dairy herd. It is reasonable to expect, given the natural area slopes and drainage, that any materials spilled within the bowl could eventually migrate into the slough. This would be particularly true along roadways and other areas of compacted soils.

The Board understands the Skinners' concern that the herbicide Picloram was detected in the slough. However, given that Picloram does not remain stable for long in the presence of oxygen and light, the Board finds it difficult to accept its presence in the slough if it has not been used for weed control in the area since 1987.

The Board recognizes that leaking screw pumps have been a problem in the past. However, it is unclear from the evidence whether or not produced oil has leaked from wellheads. The Board notes that Amax has changed all of its hydraulic-powered pumps over to electric power and believes this should eliminate the problem of hydraulic fluid leaks at the existing wellheads.

With regard to loss of agricultural land the Board notes that, in general, surface lease payments to the landowners are intended to be adequate to compensate for the interim loss of the land. In this case, the Skinners did not claim that Amax had failed to provide lease payments or were operating beyond the boundaries of their leases. Therefore, Amax was likely operating within its rights. The Board does, however, encourage all oil and gas operators to minimize the surface area disturbed by their operations, if only to reduce future surface reclamation costs. The Board would encourage Amax to do the same at existing and potential future sites. The Board notes Amax's commitment to increase communication with the Skinners and strongly encourages this initiative. Such communication in the past would likely have greatly reduced conflicts such as the dispute over the extent of tree clearing associated with the removal of fill material for construction of the 10-16 pad.

With respect to the off-site sump located at 9-16, little substantive evidence on the condition of the sump was submitted by either party. While the Board did visit the site during the hearing, the sump was snow covered. Accordingly the Board will have its field staff assess the sump's condition, including the suitability of its location compared to other possible locations, contents, fencing, future use, and need for reclamation. The Board accepts Amax's statement that the sump was not used for storage of invert muds and it would not permit the use of this sump for that purpose. The sump must be properly fenced so as to not pose a hazard to livestock.

The Board accepts the Skinner position that general site maintenance by Amax, including weed control and fencing, has not been carried out well. The Board notes that several sites have become overgrown with weeds and will require Amax to address this problem. The Board notes that since 1987 Amax has controlled weeds by mechanical means and it believes this method can be effective if applied conscientiously. The Board also believes that fencing and proper placement of pump guards has not been adequate to permit safe agricultural activity in the area surrounding the well sites. Amax will be

required to consult with the Skinners on the need for fencing at its existing well sites and ensure that guarding is in place to reduce potential hazards.

2.3.4 Effects On The Dairy Herd

2.3.4.1 Views Of The Skinners

The Skinners argued that past oil field operations were having an observable impact upon the health and productive performance of their dairy herd. They stated that from 1988 to 1990 corneal opacities were experienced in the milking cows, which are housed close to the 10-16 battery. They also experienced a number of cases of "downer" cows. Both of these conditions did not respond to common veterinary treatments. The Skinners argued that emissions from the 10-16 battery were the primary cause of these adverse impacts. Witnesses for the Skinners acknowledged that, based on research evidence, considerably greater concentrations of H_2S or SO_2 than those observed or predicted to have occurred at the farmyard would have been necessary to cause such symptoms in cattle. Notwithstanding this, they speculated that the corneal opacities could be the result of irritation by a mixture of sulphur compounds and hydrocarbon vapours from the 10-16 battery.

Herd records were presented to describe the abortion rate of the herd. The Skinners argued that the abortion rate was abnormally high during the period of battery upsets lending further evidence to their position that emissions were having a direct, negative physiological effect on their herd. The Skinners believed that bovine virus diarrhoea (BVD), which Amax hypothesised as a possible cause of eye lesions and abortions, was not a reasonable explanation because the other symptoms commonly associated with BVD were not present. Furthermore, they argued that BVD would have to be at a very advanced stage to cause the number of abortions or the severity of eye lesions observed and so the disease would have been readily detected if present.

With regard to productivity, the Skinners argued that the milk production data, while showing a gradual increase prior to 1987, should have exhibited a greater rate of increase since that time. The Skinners agreed that a modern dairy cow is already under a considerable amount of stress as a result of management to maximize milk production. Incremental stresses from oilfield facilities or activities, including noise or reduced air quality, they believed, could readily result in additional stress sufficient to reduce milk production. The Skinners said that the stress from oilfield operations is one of the causes for the lower-than-expected milk production exhibited by the herd between the summers of 1987 and 1991. The Skinners agreed a general increase in milk production had occurred during this period but contended that the increase was much lower than would be expected. They argued that the expected increase in production from improved genetics and good management between 1987 and 1991 was not fully realized primarily because of the impacts of the Amax operation.

The Skinners also argued that their management response to the problem of poor dairy performance was to increase the cull rate. They contended that their herd's cull rate was much higher than what would normally occur in a similar herd. By utilizing this technique of replacing lower than average performing cows, including cows with either low milking and/or reproductive abilities, they were able to maintain their quota volume. They maintained, however, that this strategy produced an undue economic hardship.

2.3.4.2 Views Of Amax

Amax concurred that overall the herd was well managed. Amax argued that the average milk production had increased over the period in question and that the fluctuations observed were normal for a high producing dairy herd. They also observed that with a well managed, high performing dairy herd, many variables come into play. It was not realistic, Amax contended, to expect a consistent, pre-conceived productivity increase in a herd.

Amax noted that the concentrations of H_2S or SO_2 possibly accumulating at the farmsite from its operations were at least one order of magnitude lower than the concentrations known to cause the symptoms observed in the Skinner cows. Amax also contended that the dairy farm was itself a source of H_2S emissions.

Amax argued that the suggestion that a complex mixture of emissions could reduce the effective dose of H_2S or SO_2 required to cause toxicological symptoms, while possible, was at best speculation. No comprehensive evidence with respect to complex mixtures was presented. Amax suggested that the eye lesions observed would more likely be caused by BVD and that this would also explain the high incidence of abortions and poor milk production alleged by the Skinners.

Amax argued that the cows presented on the "list of abortions" filed as evidence by the Skinners should rightly be considered possible abortions because the pregnancies had not been verified. Furthermore, Amax suggested that independent third party confirmation of alleged abortions would have been preferred, and noted that distinguishing early-term abortions from unsuccessful impregnations was difficult and subjective.

Regarding the issue of oilfield related stresses on the dairy herd, Amax argued that under modern high intensity agricultural practices, each cow is placed under such demand to maintain production that any number of factors or changes to those factors, including management inputs, could cause a reduction in performance. Furthermore, there is no research which showed that oilfield related factors increased the stress level of dairy cows.

Amax argued that a high cull rate could be indicative of good dairy herd management practice. In this case, the Skinners very successful calf rearing ability coupled with some years with higher than average numbers of female calves resulted in a large number of replacement heifers being available for use in the herd. Thus, with the large number of genetically superior replacement heifers available, cows could be culled with no economic hardship.

2.3.4.3 Views Of The Interveners

The Alberta Environmental Centre contended that H_2S or SO_2 were not likely directly causing the symptoms observed. They supported the Skinners' "gas eye" theory, suggesting that complex mixtures of sulphur and hydrocarbons were the cause, but were unable to provide any confirming evidence. They stated that nothing is known about the composition of these mixtures or the dosage which may cause physiological effects. They also stated that emissions from other oilfield facilities in the area may have contributed to the problem.

The Alberta Environmental Centre argued that available experimental data, which are based on tests using single compounds such as hydrogen sulphide, were not particularly meaningful in this instance

because the emissions represented a "complex mixture" of hydrocarbons and sulphur based compounds. They contended that such mixtures could have effects on herd health even when the concentrations of individual components were below the threshold of concern. However, they could not cite any direct or even inferential experimental data which would support their hypothesis.

The Alberta Environmental Centre concluded that the high cull rate experienced by the Skinners was the strongest evidence supporting their opinion that the Skinner herd had been affected by oilfield activities in the area. This high cull rate was, in their view, a management response to the problem. They agreed with Amax and with witnesses for the Skinners who were all of the opinion that the milk production records did not show a statistically significant difference in the level of milk production between the years in question.

2.3.4.4 Views Of The Board

With respect to physiological impacts on the Skinner dairy herd, insufficient evidence was available to convince the Board that the corneal opacities observed by the Skinners resulted from the Amax oilfield activities. However, the Board can accept that it is possible and the Board does accept the contention that no other more reasonable explanation, such as BVD, was provided at the hearing to explain the eye problems noted. In the absence of better evidence as to possible mechanisms, or a recurrence of the problem, the Board is forced to conclude that the real cause will likely remain speculative. The Board is not convinced that the dairy farm itself was such a significant source of H_2S that this could explain the eye symptoms.

With respect to the other health symptoms (i.e. increased rate of downer cows, increased abortion rates) the Board is comfortable accepting the Skinners' contention that these symptoms were real, but no evidence was presented which would either confirm or deny a linkage with oilfield operations. The Board cannot accept that the available evidence provides a definitive link between emission levels and effects on the dairy herd. While the effects appeared to be temporary, the Board believes some research effort should be encouraged to validate the speculations of some witnesses at the hearing.

The Board notes that none of the parties were able to supply a possible mechanism to link any of the observed physiological responses to the known releases of sulphur compounds and hydrocarbons from the Amax operations. The available experimental data indicate that the emissions released from the Amax batteries, satellites, and wells during individual events were not likely in sufficient concentrations to cause the physiological problems noted by the Skinners. It is possible that multiple exposures may have resulted in a cumulative effect and eventually evoked a response at an unknown exposure threshold but this is at best speculative. The Board also believes it is possible or even likely that the practice of highly selective breeding to maximize dairy cattle productivity has tended to also increase the sensitivity of dairy herds to all forms of environmental disturbance, both natural and man-made. In this case, the Board can accept the unique and unusual combination of the very intense sour oil development, the proximity of the two industries, the local bowl-shaped topography and the relative sensitivity of dairy cattle could have combined to magnify the impacts of the oilfield emissions to a level sufficient to produce a physiological response in the cattle.

It is worth noting that the health effects recorded during 1989-90 by the Skinners were no longer evident in the herd in 1991-92. Both parties agreed that significant improvements had been made in Amax's operations since that time. This would suggest a linkage does exist between herd health and

Amax's operations. It would also indicate that operation of the current Amax facility can be carried out in a manner that does not result in any obvious affect on herd health.

The contention of potential impacts by fugitive emissions from a sour oil facility on animals, and therefore by inference, possibly on human health as well, is a serious one. It is certainly one which the Board believes must be addressed. On one hand, the available experimental evidence did not support a conclusion that oilfield activity was the source of the problems. On the other hand, no alternative explanation was provided for the symptoms observed. Clearly there is significant public concern, particularly in the agricultural industry, about the potential impacts of oilfield emissions. Without clear data, however, the Board is unable to confirm that a linkage does or does not exist, much less determine the actual risks or which actions need to be taken to address these risks.

The Board is aware that the Alberta Cattle Commission (ACC) has recently commissioned a review of the available data on possible linkages between oil and gas industry emissions and livestock health. The study is being conducted by the Alberta Environmental Centre. As a first step in assessing the impacts of oilfield emissions on animal health, the Board intends to monitor the results of the ACC study. Once the study is completed, it is the Board's intention to meet with the various stakeholders, including both the energy and agriculture industries, to determine what the next appropriate steps might be to try to resolve this issue.

With regard to lost milk production, the Board accepts the Skinners' view that milk production, on a per animal basis, was potentially lower than might have been expected from 1987 to 1991. Statistical analyses, including those done by the witnesses for the Skinners, concluded that productivity did show a real, positive increase over this period. The Board is satisfied, however, that the rate of increase during that period was lower than would have been predicted.

A great deal of culling was carried out during this period. It is arguable that any suppressed improvements in milk production during the time of higher than normal culling rates will be compensated for in the future because of the overall improvement in herd genetics.

As to the causes for lower production, the Board believes it is possible that this may have been due to a direct response by the animals to the impacts (e.g. noise, dust, odours) from the nearby oilfield operations. However, this seems unlikely given that the milk-producing dairy cattle, particularly during the winter months, remain largely indoors and so would be isolated to a considerable degree from outside disturbance.

A second explanation for the reduced production during this period would be that production dropped because of less effective management practices by the Skinners. Witnesses from both sides agreed that modern dairy herd operations are complex and very susceptible to management changes. It was also agreed that high levels of stress in the dairy farmer could be directly translated into reduced production, due at least in part to a reduced ability to optimally manage the dairy herd.

During the period from 1987 - 1991, there was a marked deterioration in the relationship between the Skinners and Amax. There were numerous odour and other incidents, and a significant increase in the level of animosity and distrust between the two parties. It is almost inconceivable that this would not have had an impact on the Skinners (see Section 2.4). It seems reasonable to expect that the ability of the Skinners to optimally manage their farm would also have been affected, although such impacts may not have been evident to the Skinners. This in turn would readily explain the reduced rate of increase

in milk production. The reduction in milk production which occurred in 1986 would seem to support this view. During the summer/fall of that year, the Skinners undertook a major construction project. While this was underway, milk production in the herd declined significantly, and the Skinners believed this was due to the associated loss of their ability to dedicate as much attention as normal to the management of the dairy herd. The Board believes that similar periods of reduced ability to optimally manage the dairy herd, for the reasons noted above, may have occurred during the period 1987-91. This, in turn, resulted in reductions in milk production.

2.4 Social Impacts

2.4.1 Views Of The Skinners

The Skinners expressed deep concerns about impacts of the Amax oil activity on their lives and lifestyle. The increase in oil activity resulting from the 10-16 battery construction and related operations has resulted in a feeling among the Skinners that they are losing control of their ability to manage the dairy operations and their lives on the farm. Among the social concerns expressed by the Skinners were the increased oilfield traffic on Section 16, and the attendant noise, dust and danger associated with that traffic. Related to this issue was noise from oilfield equipment, emissions and odours from the 10-16 battery in the farmyard, and constant worry about the 10-16 battery, particularly the possibility of fires and explosions. The Skinners further described a sense of loss of their country lifestyle due to the proximity of the oilfield operations to their residences and a related loss of a pristine country setting. They expressed uncertainty about the health effects that low level emissions may have on their families and the negative effects that the oilfield operations have had on their lives, their relationships within the extended family and the activities of their children. The Skinners described a loss of faith in Amax because of its ineffective and insensitive actions in dealing with the Skinners' objections. Of particular concern was a letter wherein Amax threatened legal action if the Skinners did not withdraw their objections to the ERCB concerning the four wells in Lsd 10-16. Although the Skinners felt that operations had improved, they remained unconvinced as to Amax's long-term corporate intentions and plans to deal with the family.

Evidence was presented by the Skinners that indicated, despite their best efforts at coping with the oilfield activity, it had been psychologically wearing. The effects included anxiety, depression and physical disturbances symptomatic of unremitting stress. Witnesses for the Skinners stated that all members of the Skinner family evidenced chronically elevated levels of stress sufficient to interfere with their daily lives. Stress levels in some members of the Skinner family were sufficiently high that it was suggested this could have some lasting deleterious effect on their physical and mental health. It was contended that if operations continue as they have, the Skinners would experience more stress.

2.4.2 Views Of Amax

Amax stated that they have both proactively and reactively responded to the Skinners concerns (Appendix A). In addition, Amax emphasized a desire on the part of operating staff to improve their operations wherever possible.

Amax also tendered a list of proposals they would implement upon the continued operation of the 10-16 battery and further development of the Dina pool (Appendix B). Amax contended that the list addressed those concerns which the Skinners had brought to their attention. Although Amax

acknowledged a deteriorating relationship with the Skinners it invited continued dialogue to improve their operations wherever possible.

2.4.3 Views Of The Board

The Board is convinced that the previous operations of Amax have had a significant, negative impact on the mental and possibly the physical health of the Skinner family. The Board does not believe that the actions of Amax have been adequate to reduce the impact of their operations on this family to acceptable levels. Rather, Amax has permitted its relationship with the Skinner family to deteriorate to the point where the Board has significant concerns that a working relationship can ever be established again.

The Board accepts that the stress levels experienced by the family are real and that they are unlikely to be diminished without significant change. Further, the Board is not convinced that the proposals set out by Amax to modify their operating procedures are adequate to address the Skinners' concerns. The Board believes Amax has been particularly insensitive in appreciating the effect that the oil field activity surrounding the Skinners' homes and businesses has had on their lives.

The Board also has very serious concerns regarding the suggestion by Amax that when the Skinners had exercised their rights as landowners to request a hearing, that they may have become liable for lost opportunity costs incurred by the company. An important part of the Board's legislative mandate is to ensure that energy development is carried out in the public interest. A significant aspect of that mandate is the right for any member of the public who has a reasonable belief that they may be negatively affected to request a public hearing and to have the Board consider those concerns.

2.5 Company/Landowner Communications

2.5.1 Views Of The Skinners

The Skinners submitted that they were concerned with the type and quality of information provided them during their negotiations with Ladd. One such concern was the manner in which the approval for the 10-16 Dina battery was obtained. The Skinners noted that Ladd informed them that the proposed location was the most suitable for the battery. It was an extension of an existing surface lease for a Sparky oil well, and a clause of that agreement stated that Amax had the right to build whatever facilities it required, including a battery, for its operations. At the time of negotiations, the Skinners noted that they were not aware of their rights as a surface owner afforded them by the Acts and Regulations administered by the ERCB and were under the impression that they had no right to have input into the battery location. In addition, the Skinners stated they did not have prior knowledge that the proposed battery would be processing oil from a formation containing H_2S and that such "sour oil production" could have adverse effects on their farming and farm life. The Skinners further stated that neither representatives from the operator nor its land consultants informed them that the battery would be handling sour solution gas.

With respect to the spacing order, Board Order IW 9011, the Skinners stated that they had not granted permission to Amax to drill the large number of wells possible under the subject order nor was the possible extent of the drilling clearly explained. The Skinners believed that Amax took advantage of the infill well order IW 9011 because its application for the order only specified the need for two wells. They further stated that the surface owner should be advised of his or her rights prior to any drilling

operations taking place and should have input into selection of the most appropriate surface location for the well(s). The Skinners submitted that such an increase in activity as could occur if the holding/spacing application was approved or if Board Order IW 9011 was continued would only accelerate and compound the impacts and risks previously mentioned.

2.5.2 Views Of Amax

Amax argued that the Skinners were well aware of their rights with respect to oil and gas development on their land. It stated that the Skinners were provided copies of ERCB Guide G17-2, "Wellsite Selection and the Surface Owner", and had on occasion consulted with their lawyer on surface rights matters.

Amax submitted that it was concerned about the allegations made by the Skinners and viewed the section 42 review application as a challenge to the Company's reputation within the community. It further submitted that its relationship with the landowners has continued over the past 22 years and has been a relationship of mutual benefit and respect. Amax noted the landowners had been active participants in the oil operation by providing contract services such as road clearing, towing and surface reclamation assistance.

With respect to the 10-16 battery, Amax stated its location was decided after having regard for the area topography, operational logistics and impact on the surface area in the vicinity of the battery. The 10-16 battery was located in full compliance with the Board's guidelines at that time, and exceeds the current minimum surface facility spacing requirements. Amax stated that during the development of its oil operations, the landowners were kept advised and provided with the appropriate information packages. These summarized the landowners rights and procedures to be followed in case of disagreement. Amax stated that it had knowledge that on at least one prior occasion, the landowners had used the services of legal counsel to assist them in negotiations. Consequently, the assumption was made that the Skinners were sophisticated landowners and fully aware of options available to them in both site selection and related operations.

Amax said it is a responsible operator with a good operation and in its opinion there is no conclusive evidence which links its oil field operations to the problems cited by the landowners. In its opinion the two industries could coexist and it views the section 42 application as having no basis and serving only to further delay it from proceeding with its development.

2.5.3 Views Of The Board

The Board notes that the Amax Dina oil development in Section 16 is operating under a number of orders, approvals and permits previously identified in Section 1.1 of this report. The Oil and Gas Conservation Act, the Pipeline Act and the Oil and Gas Conservation Regulations require an operator to obtain approval from the Board through an application process prior to drilling a well, constructing production or related facilities such as batteries and pipelines or implementing a change in well spacing. The regulatory requirements for each application type is contained in the appropriate legislation and in each instance requires notification to the surface owner. Upon notification of affected parties and in the absence of objections, the application is approved and the appropriate order, approval or permit is issued.

A reasonably good and long standing working relationship between the Skinners and the energy industry on Section 16 was evident before 1987. Drilling prior to 1987 was on larger spacing units and production was largely Sparky oil that would not be as likely to create the same risks or concern for the Skinners. It would appear that any disagreements between agriculture and energy development on Section 16 prior to 1987 were mutually addressed. The Board accepts that rudimentary knowledge of legal rights and lease agreements were in place between the parties but is not convinced that the Skinners had a full opportunity to understand those rights.

It appears clear that the nature and scale of operations changed dramatically in 1987 to a sour oil operation with intense drilling. This compounded the environmental and social impacts on the farm and its residents. The Board accepts Amax's contention that literature outlining the legal recourse to object to the operation was supplied but also believes that minimal standards were adopted in siting the facilities and questionable public consultation took place. The Board accepts the Skinners' contention that they were unaware of the dramatic change in operation being proposed to the existing energy industry development on their land. The Board also believes the Skinners were within their rights to raise questions about the appropriate location of the 10-16 battery, notwithstanding the existing surface lease for that site. The Board cannot totally excuse the lack of attention that may have been given by the Skinners to the new leases requested by Amax, particularly when some legal advise was obtained at the time. The Board believes, however, that a meaningful consultative process requires energy companies to be forthright in their intent and places the largest obligation on the energy company to ensure effective communication occurs. The Board also believes its guidelines place some obligation on energy firms to recognize the social impact their operation can have on the residents in proximity to their facilities. The Board places the same obligation on companies acting as agents for an oil company. It does not believe that lease negotiations and legal consent to add facilities in this instance were necessarily carried out in that spirit.

The Board believes that at the time of the hearing all the facilities had the proper approvals and the approvals were in good standing. However, the Board recognizes there is considerable disagreement between the parties concerning negotiations and the sequence of events leading to the issuance of Board Order IW 9011, the approval of a satellite battery facility and wells in Lsd 10-16 and the approval of the 10-16 battery. The Board also notes there is a wide divergence of views between the respective parties concerning Amax's operations and the perceived impacts.

3. APPLICATIONS BY AMAX

In considering the Amax applications for well licences, additional satellite production facilities, pipelines, and holding/spacing, including some modification to the 10-16 battery, the Board believes the issues are the need for the wells and related facilities, and the impact of those additions.

3.1 Well Licence Applications

3.1.1 Need

3.1.1.1 Views Of Amax

Amax submitted that it held the rights to explore for and recover any hydrocarbons underlying Section 16 by virtue of Crown Petroleum and Natural Gas Lease Number 14220. It stated that its rights and the nature of the Dina reservoir, in particular the water coning that limits the drainage area of a well (Section 3.4.1) established a need for the 16 proposed wells and that any benefits from the proposed wells would accrue to itself, its partners, the local economy and the Province of Alberta.

3.1.1.2 Views Of The Skinners

The Skinners did not object to the rights of Amax. They did dispute the need for and the surface locations of the wells and argued that the rights of the surface owner should not be disregarded or curtailed. They argued that it was not necessary to have wells every 75 m as indicated in Amax's holding/spacing application and thus there is no need for all of the proposed wells.

3.1.1.3 Views Of The Board

The Board accepts that Amax has the right to explore for its minerals and that there would be benefits to many parties including the Province of Alberta; however, that right must be considered in terms of the economic, social and environmental impact. The Board notes that while the Skinners disputed the need for the wells they did not present an argument to dispute Amax's description of the Dina reservoir. The Board accepts Amax's argument that water coning limits the drainage areas of the wells. The Board is satisfied that, if the wells can be developed and operated with acceptable environmental and social impacts, there is a need for the wells described in the Amax application in order to maximize the recovery of the oil resource.

3.1.2 Location And Impact Of The Proposed Wells

3.1.2.1 Views Of Amax

Amax submitted that the proposed well locations (Figure 3) were selected having regard for the affects on the Skinners, the dairy operation and the environment. The selected well surface locations were further influenced by topography and the technical limitations of drilling the wells directionally.

Amax submitted that its proposed well surface locations would cause minimal land disturbance. This would be achieved by using existing well locations and by drilling the proposed wells from multiple well pads. The wells would be drilled from five existing surface locations and only an additional 1.5 ha of land would be required to drill all 16 wells.

Amax submitted that the maximum horizontal displacement possible for drilling directional wells to the Dina on Section 16 would be 350 to 400 m. Displacements greater than this would result in unacceptable increases in the costs of drilling and operating the wells, well operation problems and frequency of well servicing. The maximum displacement of the wells Amax has drilled to date is 170 m, while the maximum displacement of the proposed wells would be 290 m.

Amax stated that because of its proposed infill well program, the bottom hole locations would be restricted. The infill program and reservoir characteristics are discussed in greater detail in Section 3.4.2.

Amax submitted that it had also considered horizontal drilling technology as an alternative to directional and vertical wells. This was discounted because of technical problems associated with a horizontal well in the Dina reservoir. Production rates along the horizontal section of the well would be greater at the initial portion and less at the end of the wellbore rather than even rates along the length of the horizontal section. This results in greater draw-down and more rapid water breakthrough (coning) at the heel of the wellbore thus severely reducing efficiency. Amax referenced a published paper that analyzed and compared some horizontal well performance with vertical wells. The publication concluded that horizontal well recoveries were less than that achieved with vertical wells. Furthermore, a horizontal well did not seem to delay water coning as much as expected and cost approximately two to two and one-half times more than a directionally drilled well. It did agree that a horizontal well surface location could be at a greater distance from the farm than the proposed pad locations.

Amax also considered slant hole drilling technology and stated that a slant hole in this pool could handle a horizontal displacement up to 600 m. It believed that the proposed wells could be drilled with a slant hole rig without an adverse affect on drilling and production of the wells. The poor availability and higher costs of slant drilling and service rigs was of concern. Amax's preference, if greater separation distances than those proposed were required, would be to drill the wells directionally, using a higher kick-off point and drilling angle. This could be achieved by using more sophisticated drilling technology. This approach would increase the drilling and servicing costs of the wells. The resulting increase in wellbore angle could be handled by screw pumps without a substantial increase in rod and tubing wear.

Amax stated that it had established a minimum separation distance of 150 m from the perimeter of the farm to its proposed drilling locations. This distance is greater than the minimum separation distance of 100 m established by the Regulations and it believed that the locations would be sufficiently removed so as not to cause any undue impacts on the Skinner farm.

Amax considered the proposal put forth by the Skinners whereby any further drilling would be restricted to particular areas separated from the farm at distances greater than Amax's minimum separation distance. It stated that if it were a requirement, it could accept some of the restrictions as some of the zones established by the Skinners would still allow it to drill within its maximum horizontal displacement. Amax did not indicate which locations could be moved.

3.1.2.2 Views Of The Skinners

The Skinners submitted that the drilling and operation of the 16 proposed wells would only compound the problems they experience from the existing wells and facilities. They believed that the locations

were chosen without adequate regard to potential impacts on the dairy, the families or the environment. Rather, they were chosen with regard for Amax's desired technical requirements for directional drilling. The Skinners argued that additional wells in proximity to the farm would mean additional crews, noise, emissions, traffic, dust, stress on the family and the dairy herd, more frequent service operations and impacts to their water wells and aquifers. They believed that Amax's track record showed that it could not operate its wells diligently without causing the impacts described above and that this should be given considerable weight in the Board's decision on the proposed well locations.

The Skinners stated that in their opinion the minimum separation distances set out in the Regulations are not applicable to all situations. A 100 m separation distance from a well to a surface improvement such as a grain elevator may be appropriate but 100 m may be an entirely inappropriate separation distance to a residence or some industries. They contended that the minimum Regulation separation distance and the separation distance suggested by Amax are inadequate in this case and would not ensure acceptable protection to the dairy.

The Skinners stated that in order to reduce impacts to an acceptable level, future drilling operations should be limited to areas that are outside of the Skinner bowl. They proposed three zones (Figure 3)[2]. The Skinners requested that existing wells within the red zone be abandoned over the next two years. The yellow zone, in their view would provide an appropriate separation distance around the farmyard and residences. They requested that while the existing wells could remain on production, no further drilling be allowed within the yellow zone. They stated that locations existed outside of the yellow zone, in the white zone, that would still provide for drilling to the bottom-hole locations of the proposed wells within the maximum possible horizonal displacement submitted by Amax. This proposal is more fully described in Section 4.1.1.

3.1.2.3 Views Of The Board

The Board notes that historically, drilling and production operations in and around the Skinner farmstead have caused significant problems for the Skinner dairy and families. The Board agrees with the Skinners that impacts such as occurred from past drilling and production operations are not acceptable. The Board must consider whether the wells proposed by Amax could be drilled and operated without a repeat of past problems and if potential impacts from the proposed wells could be reduced to an acceptable level.

The Board considers the physical topography of the land, the drilling concentration and the density of agricultural and social activity on this land to be unique. The drilling and operation of Amax's proposed wells would considerably increase the activity that presently occurs in the bowl area. The Board foresees that many impacts such as noise, dust and traffic would increase proportionally. The Board believes these impacts would heighten the stress currently experienced by the Skinners and the Board does not accept Amax's contention that there would not be any undue impacts from the proposed wells. Furthermore, given the current level of activity, when combined with the proposed wells, the Board does not believe that the impacts could be reduced to an acceptable level.

[2]Figure 3 has been prepared from Exhibit 83 which used three colours--red, yellow and white, to outline the zones.

The Board agrees with the Skinners that the standard separation distance established by Regulation 2.110(1) is not appropriate for all situations. The Board believes that the Regulation reserves a discretion for the Board to determine appropriate separation distances in any particular case. While the separation distance of 150 m requested by Amax creates a greater buffer, the proposed wells are still in proximity to the Skinner farmstead and largely within the Skinner bowl. The Board sees merit in the proposal put forth by the Skinners for a restricted area around the Skinner bowl. It generally supports the proposed separation distance for Dina wells and facilities, although the Board could support a reduced restricted area if the parties agreed. The Board notes that all of the proposed wells could be drilled outside of the Skinners' yellow zone and still maintain a horizontal displacement of less than 400 m.

The Board believes that an increase in the separation distance for the drilling and operation of the proposed wells, such as set forth above, would decrease the impacts associated with the wells on the dairy and families. Most of the proposed locations would be removed from the Skinner bowl entirely. Existing well locations around the perimeter of the Skinner restricted area represent viable alternatives to the locations proposed by Amax and would allow Amax to continue its program of minimal land disturbance through pad drilling. If some of the proposed wells were denied, the Board would expect Amax to consider alternative surface locations with particular attention to maintaining a maximum distance between the proposed wells and the Skinner farm.

The Board agrees with Amax that a horizontal well may not be a viable alternative to drilling vertical or directional wells. On the basis of present horizontal well experience, it accepts the technical reasons presented by Amax for discounting a horizontal well at this time.

The Board accepts that slant hole wells may not be a viable option for increasing separation distances because of the questionable availability of rigs and increased costs. It also notes that it would be Amax's preference to utilize more sophisticated directional drilling technology rather than slant hole technology in order to increase horizontal displacement.

Notwithstanding these limitations, the Board expects Amax will use the most appropriate technology to meet the separation limits imposed.

3.2 Satellite Production Facility

3.2.1 Views Of Amax

Amax stated that it requires an additional satellite facility to the one currently operating at 10-16 to test wells that are manifolded at an existing field header on the same location. The additional satellite would be located at 10D-16 and would eliminate the installation of a line loop from the 10D-16 field header to the 10-16 battery. Amax stated that the test separator installed at the satellite would have high/low pressure and high liquid level shut-downs. Further, an instrument air compressor would eliminate the use of sour solution gas as instrument air.

3.2.2 Views Of The Skinners

The Skinners contended that historically Amax has shown it cannot operate the existing wells, satellites and battery facilities without the risk of escape of fugitive emissions, the risk of fire and explosion, the

risk of polluting surface and groundwater and the risk of polluting soil. The Skinners argued that further expansion of the Amax facilities will only add to the risks involved in operating those facilities.

3.2.3 Views Of The Board

The Board accepts that if additional wells are drilled by Amax, then new satellite facilities will be required. While the Board believes some improvements in the operating system and diligence by the operator should improve the performance above that experienced in the past the Board is not sufficiently convinced that such improvements would totally prevent a repeat of many of the incidents experienced since 1987. In this case, the final location of the satellite will be dependent on the surface location of other facilities including both the 10-16 battery and the various wells.

3.3 Pipelines Applications

3.3.1 Views Of Amax

Amax submitted that if the Board approved the 16 proposed well locations it would require the proposed pipelines in order to accommodate proration testing and treating of oil well effluent from those wells that were successful. It stated that landowner consent had not been obtained for the location of the pipelines. It stated that as the H_2S content of the well effluent was below five mole per cent the pipelines would not be required to meet sour service standards. It stated that all its Dina pipelines are installed with an internal liner that retards corrosion and it utilizes corrosion coupons and cathodic protection to monitor and prevent corrosion.

3.3.2 Views Of The Skinners

The Skinners did not dispute the need for the pipelines and stated that if the proposed wells were drilled and successful, pipelines would be preferable to trucking fluids from the wells to the battery. They did not provide comments with respect to the locations of the pipelines and believed that if wells were drilled it followed that the wells would be pipelined.

3.3.3 Views Of The Board

The Board believes that if the proposed wells were drilled and successful, there would be a need for the proposed pipelines. It agrees with the parties that pipelining well effluent is preferable to trucking the effluent because of the adverse impacts associated with trucking, particularly noise, dust, safety and the potential for odours. The Board considers the measures Amax proposes for monitoring and minimizing corrosion of the pipelines to be appropriate and if the proposed wells are approved the Board would approve the pipeline applications.

3.4 Production Facilities And Holding/Spacing Application

3.4.1 Technical Suitability Of The 10-16 Battery Modifications

3.4.1.1 Views Of Amax

Amax submitted that with the proposed expansion it will use as much of the existing facilities as possible. Only three new field satellites and one satellite expansion would be required within the field

to accommodate the gathering and testing of the wells. The total 10-16 battery fluid capacity is currently 2500 m^3/d. Since fluid flows are estimated to rise to 2500 m^3/d with the additional wells, expansion of the water handling facilities by adding a second free water knockout vessel and water settling tank would be required. By operating at less than full capacity, Amax contended that this would reduce the chance of upset and potential risk of emissions. Amax submitted that most of the oil would be recovered after water breakthrough had occurred and that eventual oil production would depend on how efficiently the water is handled. Amax stated that installing additional water capacity early in the project would assure maximum recovery.

Amax submitted no changes would be required to the oil handling facilities at the 10-16 battery in order to accommodate production from the proposed wells.

3.4.1.2 Views Of The Skinners

The Skinners objected to any further expansion of the 10-16 battery since this would only increase the risks involved in the operation of that facility. These risks are presented throughout this report.

3.4.1.3 Views Of The Board

The Board agrees that, should the scheme as proposed by Amax be approved, then expansion of the fluid handling systems of the 10-16 battery would be necessary. Other concerns of the Board with the 10-16 battery configuration and operation are set out in Section 2.2.1.3.

3.4.2 Proposed Expansion And Holding/Spacing Application

3.4.2.1 Views Of Amax

Amax submitted that the Dina is typically a fluvial sandstone deposited unconformably on the Devonian carbonates. Hydrocarbon trapping mechanisms are controlled by a combination of stratigraphic and structural components that may be partially controlled by an underlying Devonian salt formation. Primary reservoir energy is supplied by a strong, active underlying water drive.

Amax further submitted that production from the wells located in the thicker portions of the reservoir is characterized by high production rates. However, due to the difference in viscosity between the oil and water a viscous fingering effect creates a water cone. Water breakthrough usually occurs after a short period of clean oil production. Oil production declines harmonically thereafter. Amax said the water cone reduces the drainage area and the amount of recoverable oil for each well. Consequently, to achieve higher recoveries, additional wellbores are required.

Amax initiated a pilot project to evaluate infill drilling under Board Order No. IW 9011, in Lsd 10-16. This location was chosen because it was drilled out on four-ha (10-acre) spacing and production had obtained a 90 per cent water cut. The first well was drilled in 10D-16 and placed on production in March 1990. Initial production was 43 m^3/d of oil with no water, proving that recoverable oil exists between existing "watered out" wells in the pool.

Amax submitted that previous studies indicated a well drains a radius between 60 to 75 m, and believed a 100 m subsurface-interwell distance would be satisfactory. The shorter inter-well distances do not consider the heterogeneity vertically and horizontally across the reservoir. It chose potential

well locations utilizing a 100 m inter-well distance but requested a 75 m distance to avoid conflict with some existing wells.

Based on volumetric calculations Amax estimated the Dina in the area of application has an oil in place volume of 3.2 x $10^6 m^3$, of which 27 per cent or 868 x $10^3 m^3$ is recoverable. Amax estimated that the proposed expansion would result in an incremental recovery of 496 x $10^3 m^3$ oil over the present development.

Due to the limited drainage areas of the Dina wells, Amax proposes to eventually drill an additional 55 wells to complete its project. Daily fluid production would remain relatively constant and below the 10-16 battery capacity of 2500 m^3/d. Amax stated that with the additional wells planned for Section 16, there may be a total of 100 rig-days per year required for service operations of which approximately 30 would occur in the vicinity of the Skinner bowl.

Finally, Amax submitted that its proposed development would have significant economic benefits. It estimated that the cost of the wells and facilities would be 14 million dollars. Royalties paid to the Province would total 9.2 million dollars and 1.5 million dollars would be paid to the Skinners for lease rentals over the project life. It further estimated that the Town of Provost and the municipalities of Provost and Wainwright would receive approximately 14 million dollars through the life of the project.

3.4.2.2 Views Of The Skinners

The Skinners recognized that the oil industry is important to the local economy and the Province. They realize that oil is present under lands to which they own the surface rights and agree that Amax has the right and should be allowed to produce the hydrocarbons. However, the Skinners questioned the need for such a large number of wells located so close together and suggested that Amax may be trying to capture the oil more quickly in order to benefit from government incentive programs.

The Skinners said they did not oppose the Dina development and were not trying to prevent Amax from drilling, however, they are concerned about the potential for the increasing impacts arising from such a large development. The basis for their concerns and subsequent opposition to the Dina development arise from the impacts experienced from Amax's existing operations, previously discussed under Section 2.

The Skinners stated they were not prepared to give their consent to the expanded development until the conditions outlined in their development proposal outlined in Section 4.1.1 and Figure 3 are met. The Skinners emphasized that the two industries must coexist and participants in the industries must recognize and respect the rights of each other.

3.4.2.3 Views Of The Board

The Board believes that the success of both Alberta's agriculture and energy industries is fundamental to the continuing economic well being of the Province. Neither industry can automatically be considered paramount when decisions beneficial to one will have negative effects on the other. In every case, the overall public good must be carefully weighed. Equally important is the need to ensure that individual rights are protected, as a key component of protecting the broader public interest. The Board believes that the extraction of the Province's mineral wealth must be carried out in a manner which ensures that the rights of the surface owner are respected. These include the right of a landowner to a

reasonably safe and healthy environment, and to an opportunity to earn a living from that land. Before the Board can approve an energy development, it must be convinced that the applicant's proposal will protect these rights. In this case, the Board's concerns stem from both the previous actions of Amax and from the intensity and proximity of new development to the Skinners.

The Board believes that the Amax estimate of 100-rig days per year for servicing operations of an expanded operation is an optimistic view. Combined with the level of new drilling activity proposed it would be reasonable to assume that drilling/service rig operation on or around the Skinner farm could be virtually constant for the next two to three years. The majority of this development (i.e. the first 16 wells) would all be located in areas surrounding the farmstead. Even with the drilling program suggested by Amax, including use of "low noise" rigs and restriction of noisier drilling operations to daylight hours, there is no question that these activities have a high potential to significantly affect the quality of the life of the Skinners, and possibly their dairy operation as well.

The Board notes that during the hearing Amax expanded somewhat on its proposal (Appendix B) and indicated that it would be willing to consider further modifications based on proposals made by the Skinner family (Section 4.1.1). Amax did not, however, formally amend its application at the hearing, nor has it submitted an amendment to the Board.

The Board believes the concurrent development of an existing oil pool in proximity to a large established agricultural activity in this instance is unique for a number of reasons. The most significant of these is the impact that the need for intense drilling and the related activity will have on a confined geographic area competing for multiple land uses and used by a significant number of people.

The Board notes the substantial reserves projected in this pool and believes the development is economically viable and would serve the public interest.

The Board is satisfied that Amax's geological and reservoir description is reasonable and the production characteristics displayed by its wells are typical of Dina wells. The Board agrees that once a well cones water, the drainage radius of the well is limited. Consequently, to achieve better oil recoveries, additional wellbores are required. The Board is of the view that the estimate of recoverable oil is reasonable for the subject area. The Board notes that the Dina in the Hayter and Provost areas is being developed predominately on four-ha (ten-acre) DSU's with an equivalent of two-ha (five-acre) DSU's being achieved through the establishment of holding and miscellaneous spacing orders. Such development options are intended to provide sufficient flexibility to the operator to maximize recovery. Drilling spacing unit provisions of this nature will result in the drilling of a large number of wells which significantly increases the potential surface impact normally associated with oilfield operations. The Board is satisfied that the interwell spacing of 75 m in the producing formation proposed by Amax represents a sound and reasonable approach to drain the reserves. The Board also accepts the development profile proposed by Amax as orderly recovery.

The Board believes, however, that the development of a high well density play such as proposed by Amax, requires a different approach than the more traditional oil pool. Unfortunately, impacts on nearby landowners such as the Skinners can become overwhelming due to the intensity of the development. Matters such as lease access, traffic control, dust control, pollution control and well servicing operations have significant impact and must be given a higher priority in the planning process. The fact that the oil contains H_2S also has a strong bearing on how the development is carried out. In this instance the impact was compounded by the proximity of dairy and oil production facilities.

The Skinner dairy farm is a well established, sizeable operation that essentially occupies most adult members of four families. The Amax proposal in turn is competing for land in proximity to that agricultural and domestic activity. The nature of the Skinner dairy business requires the constant attention by the families. The landscape surrounding their homes and dairy operation offered a sense of seclusion and privacy in the absence of oil activity. Limited intrusions by the energy industry up to 1987 were accepted in a spirit of their mutual right to exist and develop individual interests. The Board believes that the level of activity and oil well density since 1987 was seen as an unacceptable intrusion.

While the Board believes its minimum separation guidelines for industrial and agricultural operation are reasonable for a situation involving limited facilities, the proposal by Amax requires a more comprehensive approach.

The most intrusive of the existing facilities on the Skinner farm is the 10-16 battery. Its present location on the hill represents a constant reminder to the families of a real or perceived danger and a potential source of environmental insult. The Board does not believe the present situation is acceptable in the long run nor one that will allow both operations to coexist and flourish. Given the proximity of their operations the Board expects that the proposed expansion by Amax would perpetuate an unacceptable situation in the long term and should not be approved.

The Board has concluded that developments such as those proposed by Amax must be planned on a total project basis, incorporating all aspects of the development such as well site (pad) locations, access routes and production facilities. Not only must this plan have regard for the requirements of the Provincial Acts and Regulations but also for the cumulative impact on surface use and on the occupants of the land and the other operations in proximity to the oil and gas activity.

The Board is satisfied that Amax's proposed development has positive economic benefits for the local area and the Province and, subject to some agreeable arrangement with this equally intense agricultural activity, it should be developed. The Board is not convinced, however, that the benefits from this project outweigh the negative impacts that would result from the development as presently proposed by Amax. The intensity of each of the respective industry's activity makes it difficult in this situation to find mutually satisfactory compromises.

4 ACTIONS TO ADDRESS IMPACTS

4.1 The Skinner Proposal

4.1.1 Views Of The Skinners

While the Skinner families would prefer oil and gas activity be removed from their home quarter they acknowledged this is an unreasonable expectation. In the absence of that option the Skinners offered their compromise position. They submitted that it is important to establish a "safety zone" between the dairy and oil industry activities. This would provide a comfort zone so that the local inhabitants do not have to constantly worry about mishaps occurring at the production facilities and in the long term provide the assurances required to continue their dairy operation and provide Amax with an opportunity to produce its oil.

The Skinners stated that they divided Section 16 into three separate zones designated red, yellow and white (Figure 3) depicting areas of varying levels of acceptable oilfield development. The red zone would, in their plan, be reserved solely for agricultural purposes because it contains the residences, the dairy operations and land set aside for future expansion of their operations. The red zone was largely selected to contour the high points of land surrounding the farm. In this area, there are presently nine wells and the Skinners requested that these wells be phased out of production and abandoned within two years. The surface leases would then be reclaimed and surface-lease agreements terminated.

In the yellow zone all existing wells would be permitted to continue to operate with Amax determining the longevity of the well's life. Amax would have to provide a high standard of maintenance and servicing of these wells so as to avoid impacting the dairy operations. No new wells would be permitted in this area. In general this would imply a minimum separation distance approximately 200 m from the nearest farm building.

New development drilling would only be permitted from the white zone. No restrictions would be placed on drilling in this area other than the best technology should be used to maximize the recovery of oil, while minimizing impacts and the inconvenience to the landowner.

The Skinners do not believe the existing separation distance Regulations were written with the type of oilfield development proposed by Amax in mind. In their opinion, the 100 m separation distance is not adequate in this case when the intensity of the development is considered. They feel the requirement is a minimum and should not prevent a greater distance should circumstances dictate. They believe that a larger separation distance must be established to preserve their quality of life.

With respect to the 10-16 Dina battery, the Skinners submitted that it should be moved to Lsd 4 of 16. From their perspective, this would be a good location because Amax already has an existing lease which is close to power, natural gas and a municipal road for ease of access. The most important advantage of the location is the separation distance it provides between the battery and the dairy operations. In addition, the terrain will assist in minimizing the effect of spills and other emissions previously associated with the operation of the battery. Remaining at the current 10-16 battery site would be the existing water disposal facilities, satellite test facilities and a flare stack to be used in emergency situations only. No storage of any liquids at this site would be permitted.

The Skinners believe the best way of handling the sour solution gas is to re-inject it into its zone of origin. This would eliminate the immediate and potential problems associated with handling and flaring the sour gas. Sweet gas should be used as fuel for the battery.

The Skinners said that to operate a successful dairy, they must have access to a good supply of quality water; consequently, they are concerned with both the surface and groundwater resources. They argued that their water must be tested for contaminants and a study conducted to establish groundwater flow patterns. New oil wells must have surface casing set at 25 m below the Ribstone Creek. Existing wells must have the integrity of the casing cement job verified and the extent of casing corrosion must be determined for both the surface and production casing strings. Wells no longer in service or capable of service should be abandoned immediately by filling the wellbore with cement from total depth to surface.

4.1.2 Views Of Amax

Amax considered the proposal put forth by the Skinners and believed that it could accommodate some of the requests made in the proposal. It did, however, have reservations regarding the relocation of the 10-16 battery and some of the proposed wells.

Amax submitted that it does not propose any new drilling within the Skinners' designated red zone and it recognized that within the yellow zone there is a need to move some of the proposed locations farther from the farm area. It said that it would make every effort to keep its locations outside of this zone and would work with the Skinners to accomplish this. Amax stated that the only problem area would be along the north-eastern boundary of Section 16. Complying with the Skinners' proposal for the yellow zone would necessitate moving some locations into Section 21 which would require negotiations with, and consent from that surface owner.

Amax stated that it was reluctant to agree to a two year limit on operations within the Skinner red zone because of the type of completion profiles exhibited by the Dina wells. While it agrees that a substantial volume of oil has been produced from the four wells on Pad 1 in the past two years, it indicated that the oil rates are not proportional to time. Consequently, the wells would quite likely produce for much longer than two years.

With respect to other existing wells within the Skinners' zones, Amax submitted that it has made changes to some and proposes work on others. Two wells were shut-in because of noise complaints that resulted from the hydraulic drives on those wells. Amax has a work-over operation planned for the 15B-16 well to try to shut-off water production. It stated that it does not have plans to recomplete surplus Dina wells for a Sparky waterflood.

Amax submitted that the most difficult item in the Skinner proposal to address is the relocation of the 10-16 battery. It stated that the economics of the prospect have changed considerably due to the length and cost of the hearing, and due to the likelihood of no significant number of wells being drilled prior to March of 1993 and therefore, its inability to take full advantage of the royalty holiday program currently in-place. After considering these impacts on the project economics, it estimated that the after-tax value of the project would be reduced by nearly 40 per cent. The relocation of the battery would place a very severe financial hardship on the company and put it in the position of having to re-evaluate the project.

Amax submitted that the cost of relocating the battery would be approximately 3.8 million dollars. It did not believe that relocation of the 10-16 battery is warranted because the changes it has made to the battery and the proposals in Appendix B would ensure minimal impact to the Skinners and the dairy. It did agree that measures such as relocation of the flare to a remote site or the use of an incinerator are possibilities that warrant consideration and would be prudent steps to take in order to reduce emissions.

Amax submitted certain steps to be taken in order to protect groundwater in Section 16. It proposed to monitor groundwater around the Sparky battery and the remote sump. It also considered a monitoring well that would be located in the valley near the Sparky battery. The Ribstone Creek aquifer could be monitored from an existing water well although Amax was uncertain if this would yield any new information. It stated that surface casing on any future wells would be set to a depth of 130 m and in its opinion the current practice of cementing the surface and production casing strings to surface was adequate protection. Lastly, Amax said that its well abandonment practices would protect groundwater.

4.2 Board Direction

The Board has been asked to address two issues. The first is to consider, under section 42 of the Energy Resources Conservation Act, the impacts of the Amax operations on Section 16 and to determine whether, in the Board's view, these impacts are acceptable. The second issue is to determine whether further expansion of the Amax operations on Section 16 would be consistent with the public interest.

It is clear from the evidence that past oilfield operations on Section 16 have not been without significant recurring problems. As noted earlier, the potential effects of these operational difficulties have been exacerbated by their proximity to the Skinner family farm and by the type and size of their agricultural operation. Amax has apparently dealt with a number of these problems. However, they have tended to be reactive, responding only to a complaint or serious problems, rather than proactive. Although Amax has made improvements in its operations and has indicated it intends to make more, the Board continues to have serious reservations regarding the company's long-term commitment to carrying out oilfield development in Section 16 in a manner consistent with their proximity to the Skinner family residences and the dairy farm.

With regard to existing wells, satellite facilities and pipelines on Section 16, the Board is not convinced that recision or significant amendment of these approvals is required. The Board will require Amax to ensure those facilities are maintained and upgraded in some cases. In particular, the Board will expect Amax to improve well site fencing and weed control, particularly in the calf pasture. The Board agrees that the nine Dina wells in the identified red zone confine agricultural activity and the land should be made available to the Skinners within a reasonable time period. As these wells reach the end of their economic life the Board will expect them to be abandoned and the surface reclaimed as quickly as practical. In any event, the wells should be abandoned and surface reclamation initiated within four years after the release of this decision.

The Board considers the present surface casing requirements adequate, however, it would accept Amax's proposal to set it at a depth of 130 m as an extra precaution. Full length cementing of both the surface casing and production casing is adequate protection of water aquifers. Bond logs are not necessary to assess the cement jobs unless monitoring of cement returns to surface indicates unsuccessful placement of the cement.

Plugging or isolating the producing section of a cased wellbore with cement, displacing the cased wellbore fluids with inhibited water and capping the well below ground level with a welded steel plate or cement is standard acceptable abandonment procedure and meets present Board requirements.

The Board directs that the condition of the existing sump in Lsd 9-16 be assessed as to contents, suitability of its location and construction, future use, need for reclamation and fencing. It shall not be used for invert or similar needs. The Board's staff will take part in the assessment.

The Board believes that the frequency of spill events from both Sparky and Dina operations in Section 16 to be excessive. The Board will require Amax to prepare a program to further reduce spill frequency and to confirm future surface remediation programs.

While the Board believes the proposed well completion techniques are adequate to protect water quality, it recognizes the critical nature of that supply. The Board will require Amax to set up a suitable monitoring program to detect any long-term impacts on water from its operations.

It is expected that Amax's air monitoring programs, including the environmental check list program, for Section 16 will be continued. The Board would also expect Amax to address noise issues in any future monitoring.

With regard to the 10-16 battery, the Board accepts that Amax has made many improvements to this facility, and has committed to others such as redesign of the stacks. Other options, such as addition of a remote flare or re-injection of solution gas, would likely further improve the safety and reduce the environmental impacts of the facility. Given the location relative to the farming operation the Board is not convinced, however, that these modifications would adequately reduce the potential impact on the Skinners' quality of life and allow the long-term coexistence of the agricultural and energy industries on Section 16 without recurring problems. The Board is of the view that whether the threat is real or not, the Skinners now consider the 10-16 battery to represent a totally unacceptable risk to their health, safety, and livelihood. The Board can appreciate the circumstances which led the Skinners, based on their previous experience, to this belief and the long-term operation of the 10-16 battery would only add to the risk that future upset could reoccur.

In assessing the public interest, the Board is required to weigh the positions of landowners and an energy company as to whether the negative effects of the development on the surface owner are outweighed by the overall benefits accruing to the people of Alberta. There is no question that some energy developments will intrude upon the quality of life of nearby residents, particularly in some rural environments. In this case, the Board is not convinced that the 10-16 battery, in its present configuration and current loading, represents a clear risk to the health of the Skinners' dairy cattle. The Board does believe, however, that the location of the 10-16 battery will interfere significantly with the Skinner family's quality of life, and their emotional well being and therefore may impinge on their ability to earn their livelihood from the dairy. The Board agrees with the Skinners that the separation distance requirements are intended to reflect minimum distances that may not apply to the type of oilfield operations proposed for Section 16. The Board is convinced that increased separation distances between the two operations are essential for the long-term development of both industries on Section 16.

The Board believes that the relationship between intense agricultural and oil development on the Skinner land is particularly unique. The proposed expansion would result in the operation and servicing

of some 92 wells and related facilities on Section 16. Given that intensity of oil activity, the level of agricultural activity and nature of human activity in the area, the Board does not believe that it is appropriate to have the 10-16 battery in its present location. The Board recognizes that the relocation of the 10-16 battery represents a substantial economic penalty to Amax but believes that increased separation offers the only real option to allow further development of the pool. Under suitable fiscal incentives, this alternative still provides a sizeable economic benefit to Amax and would also be in the public interest. Therefore, the Board intends, under the provisions of section 42 of the Energy Resources Conservation Act, to rescind the approval for the 10-16 battery. To provide for an orderly transition the Board is prepared to allow Amax to continue operation of the 10-16 battery for up to one year beyond the date this decision report is issued, provided the battery continues to be operated in a manner consistent with both the undertakings made by Amax and the requirements of the Board. Furthermore, the Board would also be willing to reconsider this decision should a material change occur in the relationship between the Skinners, their dairy operation, and the Amax operations although the Board would expect any other arrangement to comply with the spirit of this decision. The Board does not intend to order Amax to carry out any modifications to the existing 10-16 battery, but does expect maintenance and operations to be kept at a high level.

The Board recognizes that various options are available to achieve the requisite separation of the agricultural and oil operation. While the Board accepts the Skinner proposal to be a reasonable compromise, closer review and planning may in fact provide revisions that are of greater interest to both parties. The Board believes that only such close consultation will permit the two operations to coexist on Section 16. The Board believes other locations on Section 16 may well be suitable and it would be prepared to consider such an application as part of an overall development scheme for the pool. The Board believes that retention of satellite test facilities at the current 10-16 battery site will be appropriate but this must be specifically considered in the overall facility development plans. If free water knock-out facilities are to be used at this satellite, it must be a closed system and no storage of any liquids will be permitted.

With respect to the Amax well licence applications, the Board does not consider it appropriate to issue the licenses until the relative location of other facilities are established in light of this direction and firm plans are made on all well locations and gathering lines. The unique circumstances of this development, and particularly the potential well density, require that any new developments have appropriate separation distances from the Skinner bowl. The Board notes that the locations proposed by the Skinners appear to be technically feasible, but the Board will expect Amax to address the optimal locations in direct discussions with the landowners.

Since the need for pipeline and satellite approvals hinge on approval of the well licences, the Board is not prepared to grant these at this time. The Board agrees that effective oil recovery from the Dina pool will require more wells for the reasons discussed in Section 3.4.2 of this report. Accordingly, it is prepared to approve the holdings and the applied for spacing orders for Section 16 and the south-east quarter of Section 21, respectively, to provide well location flexibility while maintaining orderly and efficient well distribution. The Board emphasizes that this only confirms that the Board is technically satisfied the minimum well spacing applied for by Amax is necessary to drain the pool. Approval of the holding and spacing orders provides for spacing of the wells within the reservoir. It in no way assures or implies the automatic right to surface locations or production facilities for the desired wells. These must be applied for and approved through the well license, pipeline and production facilities application process. The Board considers it important in this case to address the overall development

of the pool, with particular attention to the unique multiple surface use considerations in Section 16, when filing any further well, pipeline and production facility applications.

Notwithstanding that further applications must be filed to provide for the final location of these facilities, and subject to adequate consultation between the Skinners and Amax, these applications should be able to be dealt with in a routine manner and without the further need for a public hearing.

The Board is convinced that goodwill on both sides is necessary to re-establish sufficient trust among the parties in the long run that will allow their respective operations to coexist on Section 16. Amax must recognize its operation represents an inordinate intrusion upon the Skinners, their business and their lifestyle. The Skinners in turn must respect that certain technical and cost limitations imposed on the oil industry may preclude some options that may otherwise be desirable. Health and safety of the families, however, must not be compromised in that arrangement.

To build that trust the Board recommends that Amax consider retaining a neutral facilitator at the outset of its negotiations with the Skinners. In time, the need for such a facilitator may not be necessary as both parties achieve a level of confidence that their respective interests are considered fairly in the development of the oil pool beneath the Skinner farm.

5 DECISION

Having considered the applications by the Skinners and Amax, the Board, for reasons outlined in this report, has decided:

- As to Application 910526 by the Skinners, pursuant to the provisions of section 42 of the Energy Resources Conservation Act,

 a) to allow Amax to continue operation of the 10-16 battery for up to one year beyond the date of Decision D 93-3, provided the battery continues to operate in a manner consistent with both the undertakings made by Amax and the requirements of the Board; Battery Approval No. FS04587 for the 10-16 battery will then be rescinded;

 b) to condition nine Dina wells that are located in the Skinner red zone those being, Well Licence Nos. 0126936, 0126951, 0129290, 0130379, 0143409, 0144248, 0144249, 0144250, and 0144251 so that they will be abandoned and the well site reclamation initiated within four years; no amendments or alterations are made to the other 20 Well Licence Nos. 0036069, 0077707, 0126937, 0126950, 0128313, 0128314, 0128315, 0129291, 0129293, 0130375, 0130376, 0130430, 0130921, 0131797, 0131799, 0131802, 0131803, 0140545, 0143799, and 0144255; and

 c) to permit present satellite production facilities that direct production to the 10-16 battery to remain, however the satellite facilities in the Skinner red zone shall be removed when the 9 wells in that zone are abandoned.

- To deny Amax's Applications 910890 to 910905 inclusive and Application 910790 pursuant to the Oil and Gas Conservation Regulations for well licences and for satellite production facilities respectively, and Application 910972 under the Pipeline Act for pipelines.

- To approve Amax's Application 910289 pursuant to the Oil and Gas Conservation Act and Regulations for holdings and special spacing order for wells drilled or to be drilled within the holdings. Board Orders for that purpose will be issued which will include rescission of Board Order No. IW9011.

DATED at Calgary, Alberta on 2 March 1993.

ENERGY RESOURCES CONSERVATION BOARD

F. J. Mink, P.Eng. Vice Chairman	B. F. Bietz, Ph.D, P.Biol. Board Member	N. G. Berndtsson, P.Eng. Board Member

APPENDIX A
(Exhibit 17)

MEASURES TAKEN BY AMAX
AT 10-16 BATTERY

1. Relocated access road.
2. Fugitive emission study.
3. Added additional fire fighting equipment.
4. Installed and operate air quality monitor.
5. Studies and preparation to address Application Number 910289.
 (a) soil study
 (b) hydrogeological study
 (c) ambient air quality study
 (d) inhouse and third party engineering review
 (e) environmental audit
 (f) agricultural (dairy) study
6. Installed VRU backup.
7. Replaced all thief hatch assemblies.
8. Changed procedure for thief hatch seal replacement.
9. Replaced flare stack with 60 foot flare stack.
10. Replaced all instrumentation with instrument air or non-discharging controllers.
11. Discontinued trucking of fluids to 10-16 battery.
12. Upgraded VRU at the Sparky 8-16 battery.
13. Replaced VRU lines with plastic pipe.
14. Redesigned, insulated and heated VRU and flare system.
15. Withdrew original Application Number 900435, in favour of present application.
16. Withdrew well licence applications for three wells; D3, D4, D5/10-16.
17. Voluntarily suspended operations at A2, A3, B2, D6/10-16.
18. Replacing all hydraulic drives with electric drives.
19. Suspended operations at wells 15B-16 and 10C-16 due to noise from hydraulic drives and proximity to Skinner residences.
20. Co-op gas used to fuel lineheater.
21. Improved effort and desire on part of operating staff.

APPENDIX B
(Exhibit 25)

AMAX PROPOSAL FOR CONTINUED OPERATION OF BATTERY AND HOLDING DEVELOPMENT

1. All of the changes made to the battery as already discussed will remain in-place.
2. The air quality monitor will remain on Section 16. The environment checklist program with hand-held monitors on site will continue.
3. Groundwater monitoring will continue with freshwater well sampling and the use of the existing observation wells.
4. Progressive Cavity Pumps (screw pumps) will continue to be used to minimize visual impact and noise, reduce space and servicing required for each well. All top drives will be electrically driven direct drives.
5. The existing leases will be used as much as possible to minimize surface impact. Wherever possible, leased land will be returned to use for agriculture purposes.
6. The minimum encroachment distance of 150 m proposed in the Holding Application will be respected. The fencing on Pad No. 1, will be changed to reduce the area required for well operations,and lower area on Pad No. 1, will not be used for further development.
7. The aspen stand that was in between the dairy and the battery will be replanted after permission is received from the landowners to do so. This will provide both a visual and a sound barrier between the dairy and the battery. Amax invites suggestions on landscaping to help further reduce the visual impact of the operations.
8. The project will use available spare capacity in the treater. Major changes to the oil handling facilities are not required.
9. The water handling capacity will increase to meet fluid production requirements. No additional lands will be required for the modifications.
10. The development should proceed after receiving approval from the ERCB. Project completion is expected to be in 1993.
11. Selection of drilling rigs will include a criteria for "low noise" rigs. Drilling around the interveners residence will be limited to one rig. Though drilling activity requires 24 hour operation, wherever possible, "noisy" operations will be restricted to daylight hours.
12. All construction and well servicing activities will be restricted to daylight hours.
13. Well servicing in the area adjacent to the residences will include procedures that minimize any potential for odours.
14. Amax is and will continue to implement advice from expert consultants, including Western Research, Western Oilfield and Farries Engineering. This includes existing recommendations for diking leases, treater and lineheater stack modification, weed control and soil reconditioning programs.
15. The stack upgrade proposed by Western Research is underway. In the interim, the lineheater burner operating at reduced output using Co-op fuel. Emissions will be monitored and any necessary changes will be implemented.
16. The environmental audit conducted in 1991 will be updated annually during a period of activity. Included in this audit will be participation by both the ERCB and the landowner. This will ensure that the procedures established are maintained.
17. Create a site specific vegetation management plan for both the Dina and the Sparky operation including a monitoring checklist.
18. Provide a small oil spill response trailer and site specific oil and salt-water spill control and cleanup plans.

19. Provide a site specific emergency response policy and procedure including a one complete emergency response exercise per year.
20. Development of a detailed drilling fluid control and disposal program.
21. Development of a detailed construction and drilling schedule integrated into a landowner communication and liaison program.
22. Development of access and service control/monitoring programs including contractors service specifications and training.
23. Both the landowner and the ERCB will be kept abreast of the progress of the development.
24. Amax is receptive to all reasonable suggestions regarding the development and continued operation.

APPENDIX C
AMAX OPERATIONS AT THE 10-16 BATTERY

After being processed at the battery, clean oil is directed to the oil storage tanks, produced water to the water disposal well, and produced gas is used either for fuel purposes at the battery or is directed to the flare stack. All instrument gas used at the battery is sweet gas purchased from a gas co-op. It stated that the treater burners are fuelled by produced gas and in the event of a low pressure condition from produced gas, the burners are automatically converted to sweet co-op gas. Any gas not used for fuel is burned through the flare stack.

All main process vessels are equipped with high liquid level shut-down controls and the treater and free-water knockout vessels are equipped with high pressure shut-down controls. Amax stated this leaves the pressure relief valves on the vessels as a back-up and significantly reduces the chances of fluids being diverted to the flare knockout drum in the event of a high pressure condition. Further, the fire tubes in the treater are equipped with flame failure shut-down controls and all buildings, with the exception of the motor control building, are equipped with fire and H_2S detectors. All instruments, controls and detectors are connected to the programmable logic controller (PLC) which is located in the motor control building.

The PLC is an electronic unit that monitors all vessels, fire tubes, H_2S and fire detectors, pressure and level sensors throughout the battery and initiates the shut-down of portions or all of the battery in the event of an upset. The PLC also sends a telephone alert call to the battery operator. The PLC has a battery power back-up in the event of a power outage. In the event of an emergency shut-down at the battery, the PLC causes the inlet valves to the battery to close, thus preventing further production from entering the battery. With the valves closed, the resulting higher build-up in the flow lines will activate the high pressure shut-down controls at the satellites and wells.

The water disposal system consists of two storage tanks and three positive displacement pumps. The pumps are controlled by high and low level switches located on the tanks and the water is pumped down a disposal well located at Lsd 14-16-41-1 W4M. The pumps are housed in a separate building that is equipped with H_2S and fire detectors and the tanks are tied into the VRU.

There are six product storage tanks at the battery, five of which are used for oil storage and one for condensate storage. The oil tanks are piped to a main oil pipeline. All tanks are equipped with a thief hatch to prevent over pressuring. The tanks are interconnected with over-flow lines and all are tied into the VRU. It stated there are no high and low level shut-down controls on the tanks although during normal operations only one tank is used for oil storage and shipping. The four additional tanks provide for the storage of approximately one week of production to the battery in the event of the inability to ship the oil through the pipeline.

A VRU system at the battery gathers all gas that breaks out of the water and oil within the storage tanks and directs the gas to the flare. The VRU consists of two rotary compressors that are driven by electric motors. The compressors operate singly on alternate weeks and in the event of a failure of the operating compressor the second will automatically start. If both units fail the PLC will initiate a battery shut-down. The compressors are also equipped with high temperature and high pressure shut-down controls, however, the automatic bypass eliminates the need for a low pressure shut-down control.

The battery utilizes a continuous pilot flare stack to combust all gathered vapours and unused produced gas. The continuous pilot is supplied by sweet co-op gas and is equipped with an automatic igniter to ensure that the flame is re-lit if it is extinguished. A flame arrester is located one metre below the top of the stack and a liquid catcher and drain are located at the bottom of the stack.

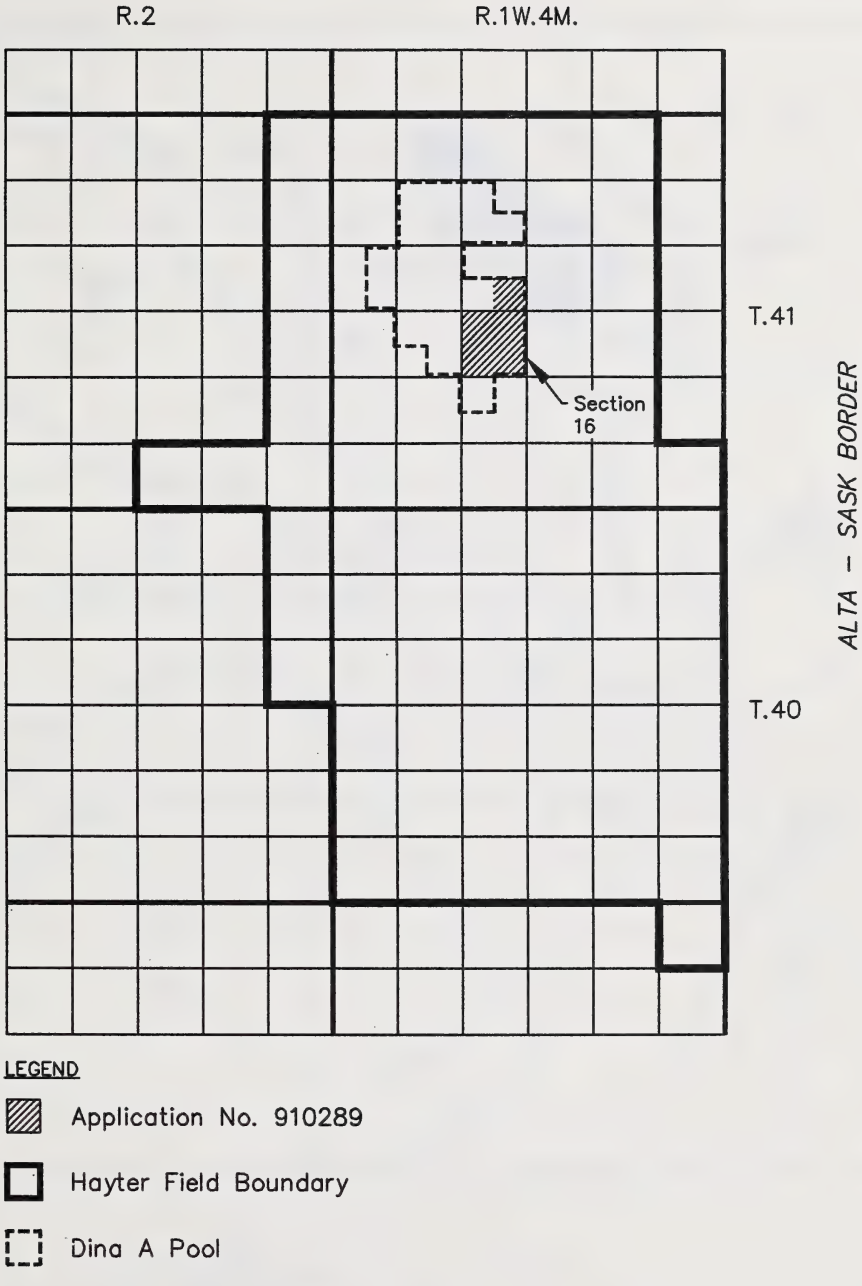


FIGURE 1
HAYTER FIELD AND AREA OF APPLICATION

16-41-1W.4M.



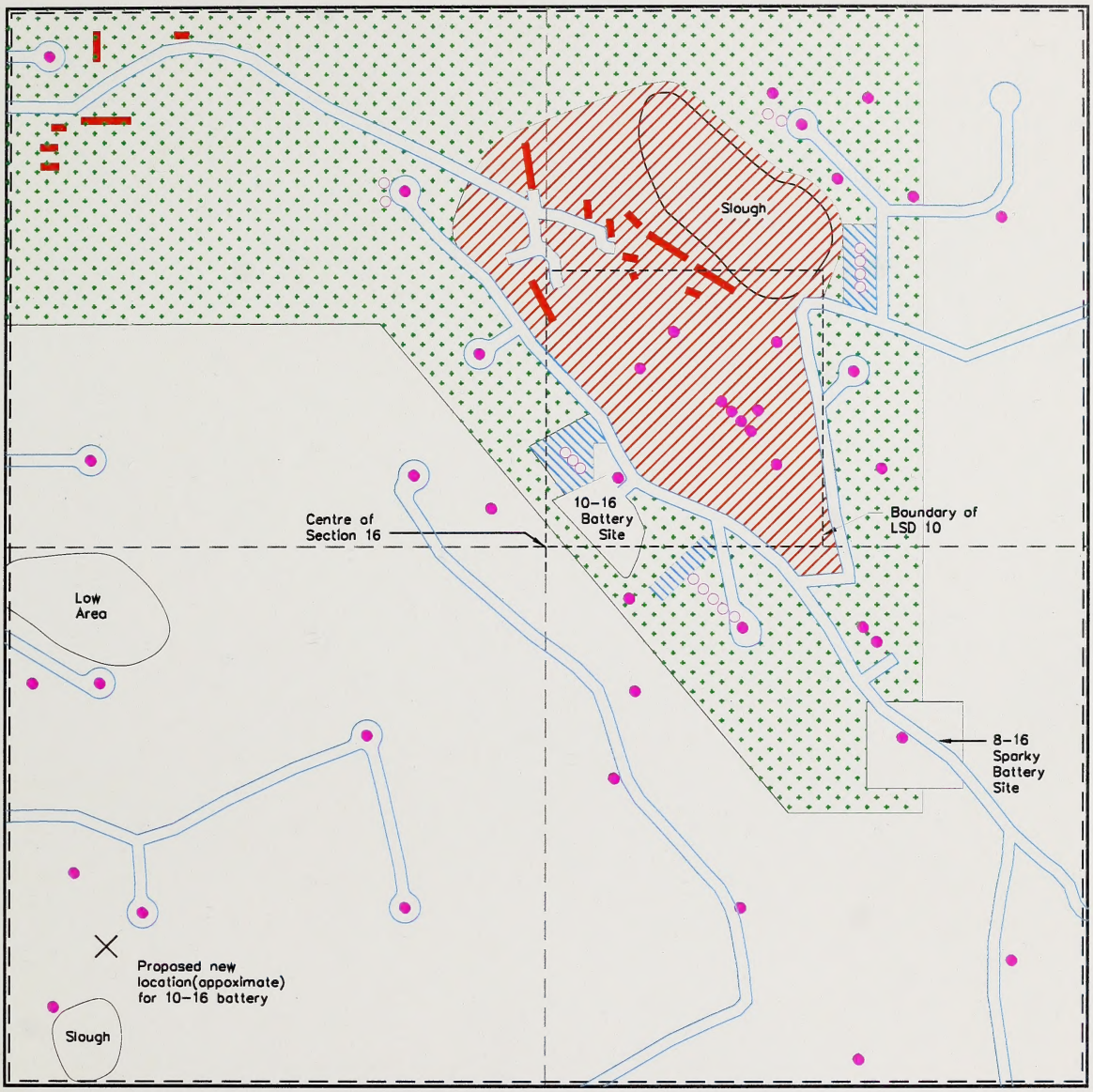
LEGEND

Oil well	Pipeline
Injection well	Abandoned well
Building	Water well
Abandoned road	No status
Existing road	Air monitoring sites A,B, and C.
Fence	

FIGURE 2 SURFACE DEVELOPMENT
SECTION 16-41-1W4M.

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16-41-1W.4M.



LEGEND

- Existing wells
- Proposed wells
- Building
- Access road
- Skinner yellow zone
- Skinner red zone
- Additional lands required for proposed wells
- --- Boundary of IW order No. 9011 (LSD 10)
- - — Boundary of proposed holding

FIGURE 3 SURFACE DEVELOPMENT
SKINNER PROPOSED SETBACK ZONES
AND AMAX PROPOSED DEVELOPMENT
SECTION 16-41-1W4M.

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